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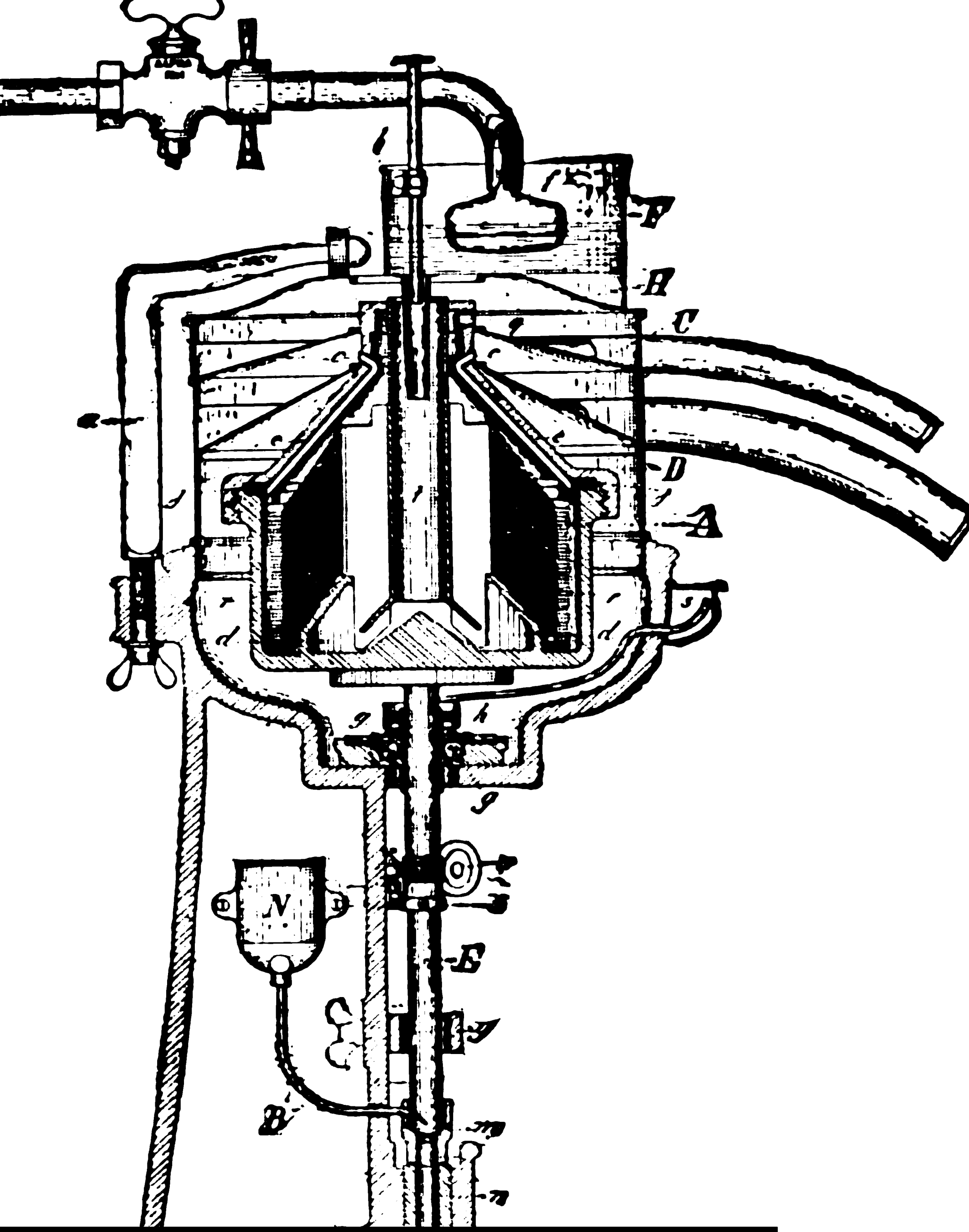
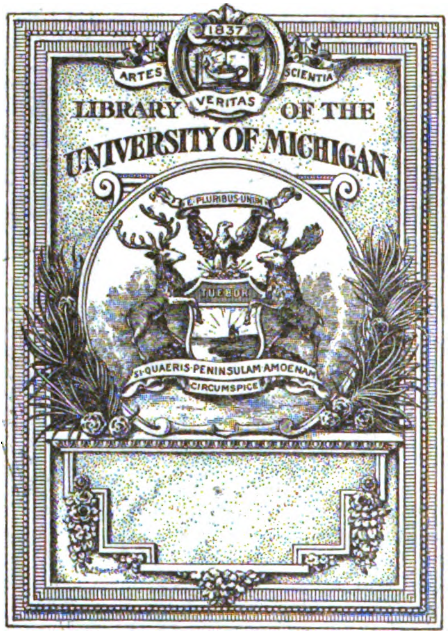


Bulletin

Agricultural Experiment Station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Nevada Agricultural

EXPERIMENT STATION,

Bulletin No. 1,

June, 1888.

History, Organization and Proposed Work of the Station.

OFFICES AND EXPERIMENTAL GROUNDS ON THE FARM
OF THE STATE UNIVESITY, RENO, WASHOE
COUNTY, NEVADA.

RENO:
STATE JOURNAL OFFICE PRINT.
1889.

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The Nevada Agricultural Experiment Station.

Bulletin No. 1.

As this station is entering upon the work contemplated by the Constitution of the State of Nevada, Article XII, Section 172, and provided for by the Act of Congress, approved March 2d, 1887, known as the "Hatch Act," it seems proper to review its past history, and also to present an outline of its plans for the future.

HISTORY.

By an Act of Congress, approved July 2, 1862, known as the Morrill Act, the State of Nevada received 90,000 acres of public lands "for the endowment, support and maintenance" of a college, in which "the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the Legislature of the State may prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

By an Act of Congress, approved July 4, 1866, seventy-two sections of public lands, or 46,080 acres, were granted to Nevada for University purposes, thereby making the total public land Congressional endowment for the University of Nevada, 136,080 acres.

More than ninety per cent. of these lands have been sold and the proceeds converted into bonds. Only the interest derived from these bonds is available for the support of the University, the principal constituting a permanent endowment for the institution.

THE NATIONAL EXPERIMENT STATION LAW.

In March, 1887, the work of experimentation in agriculture, horticulture, forestry and stock raising in our country was strengthened by what is known as the

136470

Of those physical agents by which the human race, and especially that portion of the human race engaged in agriculture, which may be said to include farming and stock raising, the first in importance is climate. Even food and soil are secondary to climate, for the food produced in any country is largely dependent upon the climate of that country, and without a favorable climate the richest soils are unproductive.

The influence of climate being thus paramount, it has been deemed advisable to publish, at this stage of the progress of our Experiment Station, a Bulletin upon this subject. The work of preparing this Bulletin was assigned to Professor Miller, who is the Botanist, Chemist and Weather Observer of the Station. His task has been performed with fidelity and accuracy, and there can be no doubt in the mind of any one who will carefully read this paper, that the climatic conditions of at least a large part of Nevada are highly favorable toward the development of agriculture among our people, and consequently of the increased prosperity of the State. Respectfully submitted,

LeRoy D. Brown, Director.

ADDENDUM.

The Nevada Agricultural Experiment Station will issue Bulletins quarterly, or oftener. These will be sent to all who request them as long as the supply lasts. Inquiries, by those interested in the work of the Station, will be replied to as promptly and fully as possible.

All communications should be addressed:

EXPERIMENT STATION,
Reno, Washoe County, Nevada.
In care of
LeRoy D. Brown, Director.

THE INVESTIGATION OF THE INTERDEPENDENCE OF PLANT LIFE AND CLIMATIC CONDITIONS OF NEVADA.

By the recent Act of Congress in the passage of the Hatch Bill, which provides for the financial assistance of State Agricultural Experiment Stations that were established at that time, or were thereafter to be established, the Board of Regents of the Nevada State University was encouraged in the establishment of the Nevada State Agricultural Experiment Station In the organization of the Station, the writer was elected to the office of Botanist and Chemist, and, in addition to the duties thereby implied, had also assigned to him the directing of the labor of taking observations on the weather and soil temperature, and the collecting of meteorological data that would truly and fully present the climatic conditions of the State and Station, in so far as they might relate to the art of agriculture.

In the work of an Agricultural Experiment Station, a definite knowledge must be had of the meteorological conditions under which certain observations have been made or certain experiments have been performed, if they would be given true and lasting value. Results thus obtained are not simply locally important, but have an absolute and general worth.

Not only for this reason should definite knowledge of the meteorological conditions be known, but also that the results obtained by other stations may be appropriated without waste.

All stations must recognize the fact that all are working to a common end, not each wholly independent of the others, but each a part of the single whole. Economy must be practiced; energy must not be wasted; results must not be deferred.

In regions that have long been settled much preliminary work of this nature has been done. In a new country, like that of the State of Nevada, all remains to be tried and determined.

Again, not only is there no definite and complete knowledge of meteorological conditions; but also, a great lack of real knowledge of the habits and properties of the native plants, a full knowledge of which is so essential in determining what plants may be introduced and cultivated with success. The agricultural resources of the State are unknown, and they will remain so for many years unless a systematic investigation of its meteorological conditions and plant-life be made. Hap-hazard trials and guessing have shown that alfalfa, *Medicago sativa*, with moderate irrigation, is an invaluable forage plant which, where water may be had, may never be displaced. But what shall be grown on the extended fertile lands that may be made to receive but the light fall of rain and snow? Methodical examination, study and trial must be resorted to.

The Board of Regents has made a very liberal appropriation for meteorological apparatus and soil thermometers, which, when secured, together with such instruments as are now possessed through the courtesy of the Nevada State Weather Service, will put the Station in condition for taking very complete and reliable records.

A very substantial thermometer shelter has beem erected after the general plan presented in Extract No. 26, from the Annual Report of the Chief Signal Officer of the United States Signal Service for 1886, and General Orders No. 3, of January 12, 1885, at a cost of about $175.

Both the shelter and support were built much stronger than directed, and were slightly modified to suit the local conditions. It was placed about seventy feet northwest of the main University building, safely anchored to sustain the greatest pressure of winds, and thoroughly painted.

A sliding frame, carrying the thermometers, may be pushed back and forward, giving them, when in the back part of the shelter, a position in the path of a vertically circulating current of air coming from a door in the floor, and passing up and over an inner false roof that is placed six to nine inches below the double roof.

The maximum, minimum, wet-bulb and dry-bulb thermometers were made by H. J. Green, of New York City, and were furnished with certificates of correction by the United States Signal Service.

A three-inch rain gauge and apparatus for determining the rate of evaporation, in addition to these thermometers, complete the list of instruments that are used at present in taking observations.

In addition to these instruments, it has been decided to secure a six-tenths inch bore standard barometer; an aneroid barometer, capable of taking altitudes to 20,000 feet above the sea; a set of maximum, minimum, wet bulb and dry-bulb thermometers; a Draper thermograph; two standard fifty square inch rain gauges; a Robinson anemometer, with Gibbon's recording apparatus; a self-recording windvane; a water thermometer; a standard thermometer; a sunshine recorder; and a set of eighteen soil thermometers, of which those for one, three, six, nine, twelve and twenty-four inches, respectively, will be in duplicate, the remaining thermometers being adapted to take soil temperatures at depths of three, four, five, six, seven and eight feet, respectively.

A complete set, ranging from one inch to eight feet, will be placed in the open uncultivated ground that is not irrigated, and the duplicate set will be placed in an alfalfa field.

With this last set it is hoped that the influence of cultivation and irrigation upon the temperature of the native soil of the Station may be shown. The rain gauges will be placed, one at the surface of the ground at the Station, another on the University building, and another on a neighboring foot-hill. This disposal of the rain gauges will be made to determine the variation of rain-fall at different elevations. Contrary to common evidence, it is expected to be shown that the greater amount will be found to have been deposited in the higher gauge. This is expected because of precipitation so frequently occurrs when the relative humidity is less than fifty per cent. At a later date, it is intended to establish observing stations on the mountain sides for taking rain-fall, relative humidity and maximum and minimum temperatures.

It is reported that frost occurs less frequently on the mountain sides and foothills than in the valleys. If this be found true, it is hoped that favorable localities for orchards and small fruits may be determined.

After a long series of observations at these sub-stations, data will be at hand to determine the influence of an increased extent of cultivated land and vegetation upon the climatic conditions of the region.

The mountains are being denuded of their forests, and trees are being planted in the valleys and foot-hills. It is predicted that the results following these changes, the development of the region, will be the reverse of the results observed in the eastern States—the humidity and rain-fall will increase and be followed by a more extended and more vigorous vegetation.

But little meteorological data has been collected in the State, the most complete record having been made by Mr. C. W. Friend, of Carson City, Director of the Nevada State Weather Service, to whom I am indebted for the data which has been collected and presented in the accompanying tables.

Carson City is situated about thirty miles south of the Experiment Station, and is about seventy feet higher.

Table No. 1, gives a summary of the meteorological record for eight years, 1880 to 1887 (inclusive), and presents the following striking features:

The warmest month is August, July being next.

The maximum temperature occurs near the middle of the month.

The coldest month is January, February being next.

The minimum temperature occurs near the end of the month.

The greatest daily range of temperature occurs in August, and the least in December.

The mean temperature of the month of May is 0.3° higher than the temperature of the year.

The mean temperature of October is 2.0° lower than the mean temperature of the year.

This shows a short, cool summer, and a long, warm winter.

The mean annual range of temperature is 102.3°.

The mean monthly range of temperature is 57.88°.

The mean daily range of temperature is 32.0°.

The highest observed temperature in the eight years is 101.0°, and occurred in the month of May in 1887.

The lowest observed temperature of the eight years was -18.0° and occurred in the month of February in 1884.

The extreme range of temperature for the eight years was 119.0°

The greatest monthly range of temperature was 79.0° and occurred in the month of May in 1887.

The mean relative humidity is but 53.7%.

The greatest precipitation occurs in December and January, being, respectively, 2.04 and 2.01 inches.

The least precipitation occurs in August, September and July, being, respectively, 0.11, 0.18 and 0.27 inches.

The mean precipitation for the month of May is but 0.31 inches.

The mean precipitation for the year is but 11.29 inches.

Frosts are liable to occur in any day of the year.

The month of August is the only month of the year in the last eight years in which, in one year or another, the temperature has not fallen below the freezing point of water.

Table No. II gives a list of places in North America (Loomis' Text Book on Meteorology) that have, in the months and seasons designated, a mean temperature that closely approximates the mean temperature of Carson City. The names of the places are arranged in the order of the relative closeness of their approximation, differing in no case by more than 5.0°. The notable fact appearing, is the approximation in temperature between Carson City and Halifax in the months from May to December, and that of Carson City and Baltimore in the months from December to May.

It is also notable that the mean annual temperature approximates that of New Haven and Boston.

Table No. III compares the mean monthly seasonal and annual temperatures of Carson City, Halifax and Baltimore, presenting interesting and surprising facts.

Table No. IV is a summary of the meteorological record for the months of October, 1887, to May, 1888 (inclusive), as observed at Reno, Nevada, by Mr. C. M. Fassett.

The lowest temperature recorded was -13.2°. The total rainfall for the eight months was 5.58 inches. The total depth of measured snow was 21.7 inches.

At this point it is also noted that the total rain-fall and melted snow at Reno for the year 1887, as observed by Surveyor-General C. W. Irish and Mr. S. G. Kendall, was 11.03 inches.

Table No. V is the complete record for the month of May, 1888, as observed by the writer, assisted by Mr. S. G. Kendall.

All readings were corrected for instrumental error, but in determining the dew point and relative humidity, no corrections were applied for altitude. The interesting fact is noted that at 2 P. M. on the fourteenth, the relative humidity was but 29.0% while at 2:30 P. M. a light rain shower was observed.

Now, with climatic conditions so different from those of the eastern States, may we not also expect to find in the State of Nevada a peculiarly characteristic flora.

The deficiency of moisture and the high rate of evaporation are the elements of the climate which vary most extremely from that of the region east of the Rocky Mountains, and in the effort of adjustment of native plant life to these conditions, is found the origin of the marked variation in the physiological and structural characteristics of our flora.

The absence of trees and succulent herbs, the presence of low and contorted shrubs, and the ever prevailing color of sage green, give to the landscape an originally characteristic appearance.

Regardless of their morphological relationship, the plants of the region may be classified from two points of view; first, with respect to the locality (varying with the temperature, altitude and amount of moisture) in which they occur; and, second, with respect to the means by which the plants of particular species adjust themselves to the general meteorological conditions of the whole region, namely, high rate of evaporation and deficiency of moisture.

In the first point of view they have been classified by Watson, in his report to Clarence King, Director of the Geological Survey of the Fortieth Parallel, into: (1) The valley flora, which includes, (a) alkaline species, (b) aquatic species, (c) species of the drier valleys and foot-hills; (2) Mountain flora.

From the second point of view they may be classified into: (1) Plants which present a small extent of surface in proportion to their volumes, usually wanting in leaves; (2) plants that have deep growing rhizomes or tubers and a relatively small extent of exposed surface; (3) plants growing from deep bulbs or corms, and having a relatively small extent of exposed surface; (4) perennial plants that have long and diverging roots which take up the deep underground moisture; (5) plants that are shrubby, have large root expansion, small extent of leaf surface and a peculiar glaucous or pubescent surface which gives the plants of the region their characteristic sage-green color; (6) small evanescent annuals that germinate, flower, ripen their fruit, produce many seeds and die, in the early spring.

It is evident that plants belonging to the sub-division, aquatic and meadow species, according to the first classification, do not permit of classification in respect to the second point of view; and again, plants occurring in different classes according to the second classification, may possess common structural characteristics that fit them for the survival of the species. One property especially that may be possessed by plants in all classes, is the pubescent or glaucous surface. The microscopical and physiological experimentative investigation of the leaves and stems of plants having this property, promises interesting results.

It is the duty of the Botanist of the Station to carefully investigate, classify and describe the native plants with reference to these two points of view, and determine the properties of those plants that best fit them to meet the enforced climatic conditions.

When these properties are once determined, cultivated plants possessing them may be given a test in their appropriate locality with some assurance of satisfactory results.

Illustrating this method of investigation, we need but to refer to certain reliable results that have been attained by unsystematic trials. Of the second class, according to the second method of classification, we have an example in the potato; of the third, in the onion; of the fourth, in alfalfa; and also, though not definitely assigned to any class, in wheat. At the New Orleans Exposition, Nevada was awarded first medals for the best quality of potatoes and wheat.

Again, it is the duty of the Botanist to investigate the properties of native plants with reference to their possible economic value and adaptability to cultivation. The Great Basin will most probably furnish its own forage plant, and that from either the order Chenopodiaceæ or Leguminosae. The investigation of the properties of plants that are readily introduced as weeds, will also doubtless lead to valuable results.

It is also especially the duty of the Botanist to make a systematic study and classification of the habits and properties of the native and introduced grasses, and to make investigations as to their adaptability to cultivation, in the experiments with which the chief condition of variation will be the quantity of water furnished them in their irrigation.

This but briefly outlines the plan of investigation by the Station of the climatic conditions and plant life of the State, with reference to their interdependence and bearing upon the art and industry of agriculture.

W. McN. MILLER.

Reno, Nevada, June 21, 1888.

TABLE NO. I.—SUMMARY OF METEOROLOGICAL RECORD FOR EIGHT YEARS, 1880–1888, FOR CARSON CITY, NEVADA.

Long. 119° 45′ 42″, Lat. 39° 9′ 51″. Altitude, 4,630 feet.

	January...	February..	March.....	April......	May......	June......	July......	August....	September.	October....	November.	December.	Annual....
Mean atmospheric pressure (inches)...........	25.386	25.344	25.337	25.276	25.314	25.306	25.367	25.346	25.354	25.373	25.419	25.385	25.350
Mean temperature........ ....(°'s F.)	32.66	32.93	40.90	47.77	50.00	56.74	62.57	68.97	59.83	47.65	36.11	35.71	49.69
Mean monthly maximum temperature.. “	58.7	58.9	71.3	77.2	90.7	94.9	98.0	96.6	90.6	79.2	67.0	60.5	78.63
Mean annual maximum temperature ... “	......	......	......	......	......	......	......	......	......	......	......	......	98.06
Mean monthly minimum temperature.. “	4.1	2.5	13.4	23.6	26.9	35.2	39.6	36.8	30.4	20.7	7.2	8.4	20.75
Mean annual minimum temperature.... “	......	......	......	......	......	......	......	......	......	......	......	......	-3.7
Mean monthly range of temperature... “	54.6	56.4	57.9	53.6	63.8	59.7	58.4	5 .8	60.2	58.5	59.8	51.9	57.88
Mean annual range of temperature...... “	......	......	......	......	......	......	......	......	......	......	......	......	102.8
Mean daily maximum temperature...... “	45.3	46.7	55.5	61.7	73.3	81.5	89.7	88.5	79.6	66.3	52.4	48.1	65.8
Mean daily minimum temperature...... “	21.2	20.8	27.9	34.1	40.3	45.8	49.8	47.6	40.5	32.0	21.9	24.3	33.8
Mean daily range of temperature....... “	24.1	25.9	28.6	27.6	33.0	35.7	39.9	40.9	39.1	34.3	30.6	23.8	32.0
Highest maximum temperature........ “	62.0	68.5	82.5	84.0	101.0	97.5	100.5	99.0	95.0	87.6	72.0	64.0	101.0
Lowest minimum temperature.......... “	-8.0	-18.0	0.0	19.5	22.0	30.0	37.0	31.0	27.5	17.5	0.0	-4.0	-18.0
Year of highest temperature......	1886	1886	1881	1881	1887	1887 1880	1885	1885	1885	1887	1885	1884	1887
Year of lowest temperature.....................	1883	1884	1880	1886	1887	1885	1886	1880	1881	1880	1881	1887	1884
Mean relative humidity (per cent.)...........	62.7	61.6	59.2	56.9	48.1	44.6	40.8	42.6	48.1	55.7	59.1	64.6	53.7
Mean monthly precipitation (inches)..........	2.01	1.43	1.63	1.67	0.31	0.48	0.27	0.11	0.18	0.43	0.99	2.04	11.29
Total number times frost was observed.......	......	......	......	138	72	41	13	19	87	......	......	......	......
Mean number times frost was observed......	......	......	......	17.3	9.0	5.1	1.6	2.4	10.9	......	......	......	......
Number years frost was observed.............	......	......	......	8	8	8	6	7	8	......	......	......	......

TABLE NO. II.

A LIST OF THE CITIES OF NORTH AMERICA, ARRANGED IN THE ORDER OF THE APPROXIMATION OF THEIR MEAN MONTHLY, SEASONAL AND ANNUAL TEMPERATURE TO THAT OF CARSON CITY, NEVADA.

January	**Baltimore; St. Louis; Richmond, Virginia.**
February	**Fort Laramie; Philadelphia, Santa Fe; Baltimore.**
March	**Philadelphia; Santa Fe; Salt Lake; Baltimore.**
April	**New York City; Ft. Snelling; Salt Lake; Salt Lake; (6) Baltimore.**
May	**Fort Brady; Toronto; Cumberland House; Halifax.**
June	**Halifax; San Francisco; Fort Brady; Cumberland House.**
July	**Halifax; Cumberland House; Astoria; Fort Brady.**
August	**Cleveland; Chicago; Boston; Buffalo; (6) Halifax.**
September	**Buffalo; Ft. Snelling; Astoria; Halifax; Toronto.**
October	**Detroit; Halifax; Ft. Snelling; Chicago.**
November	**Ft. Laramie; Toronto; Buffalo; Chicago; (6) Halifax.**
December	**Baltimore; Sitka; Philadelphia; Washington.**
Spring	**Boston; Cleveland; New Haven; Detroit.**
Summer	**Fort Brady; Astoria; Toronto; Halifax.**
Autumn	**Halifax; Buffalo; Detroit; Chicago; Toronto.**
Winter	**St. Louis; Cincinnati; Philadelphia; Baltimore.**
May to December	**Halifax.**
December to May	**Baltimore.**
Year	**New Haven; Boston; Santa Fe.**

TABLE NO. III.

A COMPARISON OF THE MEAN MONTHLY, SEASONAL AND ANNUAL TEMPERATURES OF HALIFAX, NOVA SCOTIA, AND BALTIMORE, MARYLAND, WITH THAT OF CARSON CITY, NEVADA.

	Carson City.	Mean.	Halifax.	Mean.	Baltimore.	Mean.
May.......(°'s F)	**50.0**	**54.6**	**48.0**	**53.6**	**63.1**	**65.0**
June...... “	**56.7**		**56.0**		**71.6**	
July...... “	**62.6**		**62.0**		**76.7**	
August.... “	**69.0**		**64.4**		**74.7**	
September “	**59.8**		**58.4**		**67.8**	
October... “	**47.7**		**48.0**		**55.7**	
November. “	**36.1**		**38.5**		**45.1**	
December. “	**35.7**	**38.0**	**27.7**	**28.8**	**35.6**	**39.5**
January... “	**32.7**		**22.6**		**32.8**	
February.. “	**32.9**		**23.7**		**34.2**	
March.... “	**40.9**		**30.9**		**42.3**	
April...... “	**47.8**		**38.9**		**52.7**	
Year....... “	**49.7**		**43.2**		**54.3**	

TABLE No. IV.

SUMMARY OF METEOROLIGICAL RECORD FROM OCTOBER, 1877, TO MAY (INCLUSIVE), 1888, FOR RENO, NEVADA.

Longitude 39° 31′ 15″, Latitude 119° 49′. Altitude 4,552 feet.

			1887.			1888.				
			October....	November.	December.	January...	February..	March.....	April......	May.......
Temperature.	Maximum	Mean. (°'s F)	78.5	66.4	50.5	40.3	61.0	61.1	74.0	70.2
		Highest. "	95.0	80.0	63.8	60.2	75.9	87.5	88.0	87.3
	Minimum	Mean .. "	31.4	24.1	17.4	14.1	24.4	25.3	34.0	40.1
		Lowest.. "	19.0	6.8	5.5	-13.2	13.5	12.7	20.5	26.0
	Range of.	Mean... "	47.1	42.3	33.1	26.2	36.6	35.8	40.0	30.1
		Greatest. "	57.5	53.7	47.5	35.5	50.7	57.5	51.0	47.5
		Least. .. "	25.5	20.3	12.0	15.1	14.5	15.6	16.5	10.6
Precipitation.	Number days occurred...		1	0	6	8	3	6	5	11
	Rainfall & melted snow*.		T	0.00	2.36	1.72	T	0.57	0.14	0.79
	Depth of snow fall*......		0.0	0.0	9.6	3.7	0.0	7.6	0.8	0.0
State of Weather.	Clear days....		24	19	18	7	16	12	22	21
	Fair days....		3	6	3	6	9	10	4	8
	Cloudy days.....		0	5	10	17	3	9	3	2
	Notrecorded....		3	0	0	1	1	0	1	0

T indicates trace of precipitation. * Inches.

TABLE NO. V, (b).

METEOROLOGICAL SUMMARY FOR MAY, 1888, AGRICULTURAL FXPERIMENT STATION, STATE UNIVERSITY, RENO, NEV.

Highest temperature during the month, on the 12th	87.3°
Lowest temperature during the month, on the 2d	26.5°
Mean temperature during the month	56.62°
Mean humidity during the month	44.06
Prevailing wind	West.
Maximum velocity or force (scale, 0-10)	5
Total rainfall or melted snow (inches)	.79
No. of days on which 0.01 or more rain or melted snow fell	4
No. of days on which cloudiness averaged 8 or more on a scale of ten	2
Depth of snow, in inches, on ground at close of month	0
Total snow fall, in inches, during month	0
Thunder storms, dates of	23d, 25th, 28th
Hail, dates of	24th
Frost, dates of	2d, 5th, 21st 27th

Kind of rain gauge	3-inch, with overflow and measuring stick.
Height of rain-gauge above ground	8 feet
Maker and No. of thermometer, exposed	H. J. Green, No. 2191
Maker and No. of thermometer, maximum	H. J. Green, No. 2183
Maker and No. of thermometer, minimum	H. J. Green, No. 1531
Maker and No. of thermometer, wet bulb	H. J. Green, No. 3071

REMARKS.

1. Storm on mountains SW.
2. Light frost,
3.
4.
5. Light frost.
6. First observed blooming of alfalfa.
7. Light dew.
8.
9.
10.
11.
12.
13.
14. Thunder and lightning SW at 14:00 and 21:00.
15.
16.
17.
18.
19.
20.
21. Heavy frost. Some ice at surface of ground.
22.
23. Light thunder storm.
24.
25. Light thunder storm.
26.
27. Light frost
28. Light dew. Thunder and lightning SW at 14:00. Thunder storm.
29. Heavy dew. Rainbow at 18:00.
30. Thunder W at 13:55. Lightning E at 21:00 and N at 22:30.
31. Light dew.

NEVADA AGRICULTURAL

EXPERIMENT STATION

BULLETIN NO. 3.

Meteorological Report for 1888

—BY—

WALTER McN. MILLER, B. Sc.

DECEMBER, 1888.

RENO:
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METEOROLOGICAL REPORT

FOR 1888.

The Nevada Agricultural Experiment Station is located on the farm of the State University, Reno, Washoe County, Nevada, in the approximate latitude of 39° 31″ 15′ N., and longitude 119° 49′ W. The height of the ground above the sea level is about 4,552 feet; the cistern of the barometer is 12 feet above the ground, 4,564 feet above the sea; the thermometers are in a well-constructed shelter over alfalfa sod, fifteen feet above the surface; the rain gauge is in an open field and is two feet above the ground.

All the instruments used were made by Henry J. Green, of New York, and all were provided with certificates for correcting instrumental error.

Weather observations at the Station were begun April 14th, 1888. Data of 1888 taken prior to that date and used in the following tables for comparison, were given the Station by Mr. C. M. Fassett, who was at that time acting as observer for the State Weather Service. The only instruments used by him were the maximum and minimum thermometers and a rain gauge.

The shelter then used was small, and was unfavorably situated among the buildings of Reno, and was fifty feet below the one that is now in use.

In the following tables the barometer readings have been corrected for temperature, but have not been reduced to the sea level. Also no corrections for air pressure have been applied in determining the dew point and relative humidity.

Corrections for instrumental error were made in all readings

Temperature is expressed in degrees Fahrenheit; relative humidity, in the per cent. the contained amount of moisture in the air was of the whole amount that it would have held, had it been saturated; atmospheric pressure, in inches of mercury; wind direction, as from one of the eight cardinal points; cloud proportion, in the scale of zero to ten (0 to 10)—zero meaning entire absence of clouds, and ten, sky wholly overcast.

State of weather is expressed as clear, fair, cloudy and rainy.

When the mean cloud proportion for a day, ⅓(7+2+9), was three or less, the day has been recorded as clear; when more than three and not greater than eight, fair; when more than eight, cloudy. Days have been recorded as rainy days when there was a precipitation, rain or melted snow or hail, of one one-hundredth of an inch or more.

By prevailing direction of wind at any time of day or in any period of time, is meant the direction from which it was most frequently observed to blow at that time of day or in that period of time.

Under the heading of "Remarks," at the bottom of the pages devoted to the records for the several months, it will be observed that the time of day is expressed in the twenty-four hour system.

While it is thought that the tables in themselves are usually sufficient, in the present instance it is deemed advisable to present the few following results of the year's observation:

The mean temperature for the year was 51.4°.

The mean maximum temperature was 66.7°.

The mean minimum temperature was 36.2°.

The mean daily range of temperature was 30.5°.

The highest temperature of the year was 93.1° (August 23d).

The lowest temperature was −12.7° (January 14th).

The total range of temperature for the year was 105.8°.

The highest mean temperature for any day was 74.7° (August 7th).

The lowest mean temperature for any day was −1.15° (January 14th.)

No day was so cold but that the mercury rose to 10.4° as a maximum temperature.

No night was so hot but that the mercury fell to 62.3° as a minimum temperature.

The total precipitation for the year was 7.4 inches.

The total number of clear days was 216.

The total number of fair days was 95.

The total number of cloudy days was 55.

The total number of rainy days was 49.

In the months from July to October, inclusive, no day was recorded as cloudy.

The station is now in possession of the following instruments, in addition to those by which the accompanying data were obtained, viz: A set of fifteen soil thermometers; a Robinson anemometer and electrical recording apparatus; a maximum solar radiation thermometer; a minimum terrestial radiation thermometer. These will soon be placed for observation and then additional data can be given.

It is earnestly recommended that the Station immediately supply itself with first-class continuous self-recording meteorological instruments, and a few pieces of the physical apparatus. The meteorological conditions of the Great Basin are unlike those of other regions of the United States, and consequently original investigations must necessarily be made for the establishment of formulæ and tables that will be truly applicable to the meteorological work of this Station.

WALTER McN. MILLER,
Botanist, Chemist and Meteorologist.

RECORD FOR JANUARY.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.; ALTITUDE, 4,500 feet:
120th W. Meridian Time.

DAY OF MONTH....	TEMPERATURE.				Total am't of melted snow and rain in inches and hundredths........	State of Weather..	REMARKS.
	Maximum temperature.	Minimum temperature	Range of temperature.	Mean temperature. $\left(\frac{\text{Max}+\text{Min.}}{2}\right)$			
1..	42.9	19.5	23.4	31.20	.04	cloudy	snow
2..	51.5	30.5	21.0	41.00	0 0	cloudy	....
3..	42.9	25.3	17.6	34.10	1.15	fair	snow
4..	40.4	17.3	23.1	28.85	.06	cloudy	snow
5..	35.0	15.6	19.4	25.30	.15	cloudy	snow
6..	31.0	9.0	22.0	20.00	.00	clear	....
7..	23.5	-9.0	32.5	7.25	.00	clear	....
8..	23.6	-11.0	34.6	6.30	.00	clear	....
9..	24.2	-10.8	35.0	6.70	.00	clear	....
10..	27.0	-4.5	31.5	11.25	.00	clear	....
11..	33.4	0.5	32.9	16.95	.00	clear	....
12..	40.9	9.0	31.9	24.95	.00	fair	....
13..	37.7	9.5	28.2	23.60	.03	cloudy	snow
14..	10.4	-12.7	23.1	-1.15	.00	clear	....
15..	15.5	-11.6	27.1	1.95	.00	clear	....
16..	19.7	-10.7	30.4	4.50	T	fair	snow
17..	28.1	-4.5	32.6	11.80	.00	fair	....
18..	28.5	-3.5	32.0	12.50	.00	fair	....
19..	36.0	17.0	19.0	26.50	.00	cloudy	....
20..	37.3	22.8	14.5	30.05	.06	cloudy	snow
21..	57.5	29.5	28.0	43.50	.00	cloudy	....
22..	53.0	30.5	22.5	41.75	.00	cloudy	....
23..	63.4	32.0	31.4	47.70	.22	cloudy	....
24.	51.3	25.0	26.3	38.15	.00	cloudy	....
25..	60.1	35.5	24.6	47.80	.00	cloudy	....
26..	46.3	27.0	19.3	36.65	.00	cloudy	....
27..	54.3	30.5	23.8	42.40	T	cloudy	rain
28..	53.9	30.5	23.4	42.20	.01	cloudy	rain
29..	60.2	37.6	22.6	48.90	.00	cloudy	....
30..	58.9	42.2	16.7	50.55	.00	cloudy	....
31.	60.0	34.0	26.0	47.00	.00	fair	....
Sum.	....	.....	.....	......	1.72	...	....
Mean	40.27	14.58	25.69	27.43	....	cloudy	....

RECORD FOR FEBRUARY.

RENO, NEVADA.

Latitude, 39° 31′ 15″ N.; **Longitude**, 119° 49′ W.; **Altitude**, 4,500 feet; 120th W. Meridian Time.

Day of Month....	Temperature.				Total am't of melted snow and rain in inches and hundredths.........	State of Weather..	Remarks.
	Maximum temperature.	Minimum temperature.	Range of temperature.	Mean temperature. (Max.+Min. / 2)			
1..	55.7	32.5	23.2	44.10	.00	fair	....
2..	52.1	20.5	31.6	36.30	.00	clear	....
3..	51.0	20.5	30.5	35.75	.00	clear	....
4..	53.3	22.1	31.2	37.70	.00	clear	....
5..	49.5	23.9	25.6	36.70	.00	clear	....
6..	59.5	18.9	40.6	39.20	.00	clear	....
7..	63.0	21.5	41.5	42.25	.00	clear	....
8..	68.5	23.5	45.0	46.00	.00	clear	....
9..	58.5	24.9	33.6	41.70	.00	cloudy	....
10..	53.0	39.1	13.9	46.05	T	cloudy	rain
11..	61.5	38.6	22.9	50.05	.00	fair	....
12..	58.0	39.6	18.4	48.80	T	fair	rain
13..	63.0	25.5	37.5	44.25	.00	fair	....
14..	59.2	25.6	33.6	42.40	.00	fair	....
15..	53.0	26.7	26.3	39.85	.00	fair	....
16..	62.0	27.0	35.0	44.50	.00	fair	....
17..	66.0	27.5	38.5	46.75	.00	clear	....
18..	64.0	26.5	37.5	45.25	.00	clear	....
19..	57.0	16.0	41.0	36.50	.00	clear	....
20..	54.5	15.5	39.0	35.00	.00	clear	....
21..	61.5	15.5	46.0	38.50	.00	clear	....
22..	62.5	21.5	41.0	42.00	.00	clear	....
23..	70.0	23.4	46.6	46.70	.00	clear	....
24..	60.0	25.5	34.5	42.75	.00	clear	....
25..	70.5	22.8	47.7	46.65	.00	clear	....
26..	74.0	24.5	49.5	49.25	.00	clear	....
27..	72.8	32.8	40.0	52.80	.00	cloudy	....
28..	75.9	25.7	50.2	50.80	T	fair	rain
29..	60.8	14.0	46.8	37.40	.00	fair	....
....	....	....	....	.....	...	....	....
....	....	....	....	.....	...	....	....
Sum.	.....	.....	.....	....	T	..	....
Mean	61.04	24.88	36.16	42.96	....	clear	....

RECORD FOR MARCH.

RENO, NEVADA.

Latitude, 39° 31′ 15″ N.; Longitude, 119° 49′ W.; Altitude, 4,500 feet, 120th W. Meridian Time.

Day of Month.	TEMPERATURE.				Total am't of melted snow and rain in inches and hundredths.	State of Weather.	REMARKS.
	Maximum temperature.	Minimum temperature.	Range of temperature.	Mean temperature. $\left(\frac{\text{Max.+Min.}}{2}\right)$			
1..	39.1	13.2	25.9	26.15	.00	cloudy	snow in eve'g
2..	41.9	24.2	17.7	33.05	.23	cloudy	rain till 9 A.M.
3..	43.9	20.5	23.4	32.20	.00	fair	....
4..	37.8	22.8	15.0	30.30	.29	cloudy	snow
5..	42.7	19.0	23.7	30.85	.00	clear	....
6..	56.0	25.7	30.3	40.85	.00	fair	....
7..	57.2	28.5	28.7	42.85	.00	fair	....
8..	57.0	26.4	30.6	41.70	.00	fair	....
9..	54.0	22.0	32.0	38.00	.05	fair	snow
10..	63.0	19.1	43.9	41.05	.00	fair	....
11..	69.3	22.9	46.4	46.10	.00	fair	....
12..	75.0	27.7	47.3	51.35	.00	cloudy	....
13..	87.5	28.5	59.0	58.00	.00	cloudy	....
14..	51.5	32.5	19.0	42.00	T	cloudy	rain
15..	64.0	26.4	37.6	45.20	.00	clear	....
16..	67.5	26.6	40.9	47.05	.00	clear	....
17..	76.5	27.5	49.0	52.00	.00	clear	....
18..	68.9	36.7	32.2	52.80	.00	clear	....
19..	65.5	25.0	40.5	45.25	.00	clear	....
20..	72.0	24.5	47.5	48.25	.00	clear	....
21..	71.0	29.1	41.9	50.05	.00	fair	....
22..	75.2	31.1	44.1	53.15	.00	fair	....
23..	63.0	29.5	33.5	46.25	.00	cloudy	....
24..	59.0	33.0	26.0	46.00	.00	fair	....
25..	61.0	16.7	44.3	38.85	.00	clear	....
26..	53.6	15.0	38.6	34.30	.00	clear	....
27..	64.0	16.5	47.5	40.25	.00	clear	....
28..	69.2	16.2	53.0	42.70	.00	clear	....
29..	64.4	34.5	29.9	49.45	.00	clear	....
30..	68.8	37.0	31.8	52.90	.00	cloudy	....
31..	55.5	38.5	17.0	47.00	T	cloudy	rain
Sum.	....	....	....	......	.57	......	....
Mean	61.13	25.70	35.43	43.42	....	clear	....

RECORD FOR APRIL.

RENO, NEVADA.

Latitude, 39° 31′ 15″ N.; Longitude, 119° 49′ W.; Altitude, 4,500 feet, after 13th 4,552 feet; 120th W. Meridian Time.

Day of Month...	TEMPERATURE.				Total am't of melted snow and rain in inches and hundredths........	State of Weather..	REMARKS.
	Maximum temperature.	Minimum temperature.	Range of temperature.	Mean temperature. $\left(\frac{\text{Max.}+\text{Min.}}{2}\right)$			
1..	67.0	35.4	31.6	51.20	.00	clear	....
2..	65.5	24.0	41.5	44.75	.00	clear	....
3..	63.7	27.4	36.3	45.55	T	fair	rain
4..	58.5	33.5	25.0	46.00	.00	fair	....
5..	67.7	21.0	46.7	44.35	.00	clear	....
6..	70.0	26.1	43.9	48.05	.00	clear	....
7..	74.0	23.5	50.5	48.75	.00	clear	....
8..	74.0	25.1	48.9	49.55	.00	clear	....
9..	73.2	24.9	48.3	49.05	.00	clear	....
10..	80.0	32.8	47.2	56.40	.00	clear	....
11..	84.0	37.0	47.0	60.50	.00	clear	....
12..	86.0	36.5	49.5	61.25	.00	clear	....
13..	88.0	38.1	49.9	63.05	.00	clear	....
14..	85.2	37.9	47.3	61.55	.00	clear	1st observation
15..	77.4	41.1	36.3	59.25	.00	fair	[at station
16..	71.2	33.5	37.7	52.35	.00	fair	....
17..	76.9	34.0	42.9	55.45	.00	clear	....
18..	79.2	37.5	41.7	58.35	.00	clear	ulmus suberosa
19..	83.0	35.5	47.5	59.25	.00	clear	[fruit ripe
20..	85.8	36.7	49.1	61.25	.00	clear	....
21..	86.0	43.6	42.4	64.80	.00	clear	thunder sw17:30
22..	84.5	45.6	38.9	65.05	.06	cloudy	rain 1st thun.st.
23..	70.5	44.1	25.4	57.30	T	cloudy	rain
24..	56.1	40.0	16.1	48.05	T	cloudy	rain
25..	49.5	33.5	16.0	41.50	.08	clear	snow
26..	64.0	24.7	39.3	44.35	.00	clear	very heavy frost
27..	68.3	38.8	29.5	53.55	.00	clear	....
28..	77.1	38.1	39.0	57.60	.00	clear	earthquake at
29..	78.1	40.6	37.5	59.35	.00	clear	[20h 48′ 38″
30..	74.8	42.1	32.7	58.45	.00	clear	....
....	....	....	....	....	...	......	....
Sum	.....	.....	.....	......	.14	......	....
Mean	73.97	34.42	39.55	54.20	....	clear	....

RECORD FOR MAY.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′.

Day of month........	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.)........	Daily mean relative humidity ⅓(7+2+9.)....	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.....	Hum......	Temp.	Hum	Temp....	Hum.. .				
1....	43.5	74.0	55.0	86.2	46.0	38.0	47.63	66.07	58.0	42.1
2....	45.0	24.8	78.6	2.0	53.1	21.9	57.45	16.23	68.5	26.5
3....	48.0	48.8	54.0	59.4	48.0	66.5	49.50	58.07	59.0	47.7
4....	46.4	62.8	65.4	26.6	44.4	58.8	50.15	49.40	66.4	43.7
5....	47.0	53.0	71.0	17.0	58.3	41.1	58.65	37.03	73.2	36.6
6	54.0	53.6	68.0	15.1	51.2	32.8	56.10	33.83	71.1	41.1
7 ...	48.3	52.1	76.0	19.3	60.0	39.8	61.08	37.07	76.0	35.3
8....	51.3	56.9	79.0	14.0	55.0	42.0	60.08	37.97	79.0	38.6
9....	53.0	52.6	76.4	18.2	58.6	34.8	61.65	35.20	77.4	40 0
10....	58.4	44.8	74.1	22.8	57.0	22.2	61.63	29.93	76.0	48.6
11....	52.0	41.5	77.0	9.0	56.0	39.0	60.25	29.83	77.8	37.9
12....	56.3	43.1	86.3	2.7	69.3	29.1	70.30	24.97	87.3	40.4
13....	55.3	37.1	85.0	13.0	60.0	37.0	65.08	29.03	86.3	47.9
14....	54.0	62.8	70.0	29.0	52.0	66.0	57.00	52.60	71.6	46 7
15....	46.0	85.0	56.0	50.0	49.5	70.0	50.25	68.33	62.0	42.6
16....	57.4	48.6	61.6	51.6	57.0	31.0	58.25	13.73	77.0	44.6
17....	50.2	60.0	72.0	19.5	60.1	43.4	60.60	40.97	74.0	39.1
18 ...	55.0	65.0	73.0	32.0	60.2	24.6	62.10	40.53	75.0	45.4
19....	53.0	58.0	68.2	22 6	54.7	71.8	57.65	50.80	71.0	41.6
20....	57.0	36.0	65.1	8.3	49.1	86.8	55.08	43.70	66.2	39.4
21 ...	44.0	34.0	62.2	11.4	52.2	28.2	52.65	24.53	66.0	32.7
22....	49.3	45.3	64.1	59.7	52.2	39.0	54.45	48.00	68 0	38.2
23....	42.2	98.4	50.5	70.5	48.5	63.0	47.43	77.30	62.2	39.3
24....	44.1	85.0	46.3	61.3	43.0	58.6	44.10	68.30	51.0	41.0
25...	43.1	54.3	53.0	25.0	44.0	54.4	46.03	44.57	55.7	38.2
26....	46.0	59.2	55.0	39.2	49.0	54.0	49.75	50.80	57.3	38.5
27....	47.3	69.0	65.8	23.6	59.0	38.0	57.78	43.53	69.0	37.2
28....	58.0	53.0	66.4	34.8	54.4	40.0	58.30	42.60	71.6	43.4
29....	51.0	74.0	73.0	29.0	60.3	47.1	61.15	50.03	74 4	40.6
30....	55.5	60.7	65.0	39.0	57.2	53.6	58.73	51.10	72.6	50.4
31....	57.1	67.8	74.2	13.6	63.0	38.8	64.33	40.07	76.0	45.6
Sums.	.....	......	......	.....	......	......	......	.....	......	......
Means	50.60	56.81	67.33	29.85	54.27	45.54	56.62	44.06	70.21	40.74

REMARKS:

1. Storm in mountains SW.
2. Light frost.
5. Light frost.
6. First observed blooming of alfalfa.
7. Light dew.
14. Thunder and lightning SW at 14:00 and 21:00.
21. Heavy frost, thin ice.

RECORD FOR MAY.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian time.

Day of Month.........	Range of temperature...	Daily mean barometer ⅓(7+2+9.).........	Precipitation in inches...	Snow in inches.........	WIND. Direction from. 7 A. M...	WIND. Direction from. 2 P. M...	WIND. Direction from. 9 P. M...	WEATHER. Cloud proportion (scale 0 10.) 7 A. M...	WEATHER. Cloud proportion (scale 0 10.) 2 P. M...	WEATHER. Cloud proportion (scale 0 10.) 9 P. M...	WEATHER. State.
1....	15.9	.....	(r) T	0.0	n	n	nw	3	4	2	clear
2...	42.0	......	.00	0.0	nw	nw	w	0	3	2	clear
3 ..	11.3	......	(r).02	0.0	e	ne	w	10	10	10	cloudy
4....	22.7	......	.00	0.0	nw	n	nw	6	2	0	clear
5....	40.6	......	.00	0.0	nw	e	nw	0	x	0	clear
6	30.0	......	.00	0.0	e	ne	w	0	1	0	clear
7...	40.7	......	.00	0.0	nw	e	w	0	1	x	clear
8....	40.4	......	.00	0.0	ne	sw	nw	2	4	0	clear
9....	37.4	......	.00	0.0	e	w	nw	1	3	x	clear
10....	27.4	.....	.00	0.0	n	ne	w	2	3	x	clear
11....	39.9	......	.00	0.0	e	e	nw	0	x	2	clear
12....	46.9	......	.00	0.0	e	ne	nw	x	5	3	clear
13....	38.4	......	.00	0.0	e	sw	n	0	6	x	clear
14....	28.9	......	(r) T	0.0	e	e	sw	6	9	5	fair
15 ..	19.4	.....	(r).31	0.0	w	w	w	6	9	8	fair
16....	32.4	......	.00	0.0	se	w	e	4	4	0	clear
17....	34.9	.....	.00	0.0	w	e	w	0	0	0	clear
18....	29.6	......	.00	0.0	e	sw	w	1	4	x	clear
19...	29.4	.....	.00	0.0	e	w	w	x	2	1	clear
20....	26.8	......	.00	0.0	e	sw	nw	4	3	0	clear
21....	33.3	......	.00	0.0	nw	w	....	0	3	2	clear
22....	29.8	.....	.00	0.0	e	sw	w	1	4	4	clear
23....	22.9	......	(r).29	0.0	se	e	w	3	10	8	fair
24....	10.0	......	(r&h).17	0.0	e	sw	w	8	9	9	cloudy
25....	17.5	......	(r) T	0.0	w	sw	w	4	8	2	fair
26....	18.8	......	(r) T	0.0	nw	nw	nw	4	6	3	fair
27....	31.8	....	.00	0.0	e	e	nw	2	3	x	clear
28....	28.2	......	(r) T	0.0	ne	w	sw	x	9	x	clear
29....	33.8	....	(r) T	0.0	e	e	w	x	3	x	clear
30...	22.2	......	(r) T	0.0	sw	w	sw	10	5	1	fair
31....	30.4	.....	.00	0.0	e	sw	w	6	7	10	fair
Sums	.....	......	.79	0.0	....	....	....	....	....	....	....
Means	29.47	......	....	.....	e	e-sw	w	2.7	4.5	2.3	clear

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

23. Light thunder storm.
27. Light frost.
28. Light dew, thunder storm.
29. Heavy dew.
30. Thunder W at 13:55, lightning E at 21:00 and N at 22:30.
31. Light dew.

RECORD FOR JUNE.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′.

Day of month.	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.)	Daily mean relative humidity ⅓(7+2+9.)	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.	Hum.	Temp.	Hum.	Temp.	Hum.				
1....	58.7	47.8	54.7	59.3	52.7	55.9	54.70	54.33	63.0	49.7
2....	49.8	72.0	61.9	48.4	53.2	57.0	54.52	59.13	64.3	40.5
3 ...	51.8	43.4	54.7	39.3	44.8	64.6	49.00	49.10	57.0	45.0
4....	47.0	59.0	62.7	33.9	54.7	30.3	54.78	40.97	64.4	39.4
5....	49.7	73.1	63.7	36.8	57.7	34.3	57.20	48.07	71.0	42.6
6 ...	53.7	41.7	54.7	26.5	42.9	62.7	48.55	43.63	60.1	42.6
7 ...	44.7	58.5	61.7	32.9	55.2	42.6	54.20	44.67	64.4	36.7
8....	51.7	63.3	71.9	18.2	62.7	38.9	62.25	40.13	76.0	48.5
9....	53.3	72.3	74.9	15.2	57.1	25.7	60.60	38.07	75.1	47.1
10 ...	52.7	53.5	72.1	14.8	61.7	26.5	62.05	31.60	73.0	42.0
11 ...	55.3	52.5	76.0	19.0	65.8	65.8	65.73	45.77	78.4	44.6
12....	60.6	46.2	67.5	35.9	58.8	52.6	61.43	44.90	71.1	57.0
13....	60.9	49.7	67.1	34.3	62.1	45.5	63.05	43.17	68.8	49.8
14....	64.7	40.5	64.7	37.5	60.9	50.5	62.80	42.83	67.7	57.7
15....	61.7	45.8	68.7	21.6	54.5	47.3	59.85	38.23	70.7	54.7
16 ...	48.5	69.5	72.3	16.8	56.7	33.6	58.55	39.97	75.4	39.6
17....	49.7	60.7	51.9	73.1	49.4	69.4	50.10	67.23	57.0	47.4
18 ...	46.9	92.0	70.9	20.2	51.7	46.9	55.30	53.03	71.0	37.7
19....	52.0	48.0	63.9	22.3	51.4	47.0	54.73	39.10	65.0	46.8
20....	47.7	67.8	69.5	20.0	59.5	23.7	59.05	37.17	74.0	37.3
21 ...	52.7	53.5	79.3	11.0	56.6	35.2	61.30	33.23	80.1	41.0
22....	55.7	64.4	84.9	10.2	71.8	21.4	71.05	32.00	86.0	48.1
23....	61.9	49.1	84.7	5.7	72.4	41.2	72.85	32.00	84.0	50.7
24....	59.1	46.7	80.6	14.8	69.5	28.5	69.68	30.00	83.8	51.0
25...	68.8	31.2	80.6	21.2	69.7	30.7	72.20	27.70	82.0	52.4
26....	63.6	55.4	82.0	19.4	67.8	43.0	70.30	39.27	83.5	52.7
27....	67.1	28.4	73.9	6.1	57.9	11.0	64.20	15.17	75.0	57.7
28....	53.1	31.5	67.6	9.4	52.8	39.0	56.58	26.63	70.8	40.2
29....	52.9	42.7	65.8	9.8	54.3	34.6	56.83	29.03	66.4	43.8
30....	49.7	47.5	66.2	16.8	55.4	31.8	56.65	32.03	68.2	40.9
.....	....	....	....	....	....	....	....	....	....	....
Sums.	....	......	......	....	......	......	.....	....	......	......
Means	54.86	53.59	69.04	25.01	58.06	41.24	60.00	39.96	71.57	46.17

REMARKS:

2 Sheet lightning at 21:15.
8. Brilliant solar halo.
11. Solar halo at 14:00.
16. Solar halo at 7:00.
18. Heavy dew.
19. Rainbow at 5:55.

RECORD FOR JUNE.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian Time.

Day of month......	Range of temperature...	Daily mean barometer ⅓(7+2+9.)	Precipitation in inches..	Snow in inches........	WIND. Direction from. 7 A. M...	2 P. M...	9 P. M...	WEATHER. Cloud-proportion (scale 0-10.) 7 A. M...	2 P. M..	9 P. M...	State.
1....	13.3	.....	(r).05	0.0	w	w	w	9	9	7	cloudy
2...	23.8	......	(r).03	0.0	se	w	w	7	4	1	fair
3...	12.0	......	(r) T	0.0	w	sw	w	2	4	6	fair
4...	25.0	......	.00	0.0	nw	ne	nw	4	3	x	clear
5....	28.4	.....	.00	0.0	w	w	w	4	7	6	fair
6...	17.5	......	.00	0.0	sw	w	w	4	3	3	fair
7...	27.7	.....	.00	0.0	nw	ne	w	2	3	3	clear
8....	27.5	.....	.00	0.0	e	n	nw	0	3	1	clear
9....	28.1	.....	.00	0.0	n	sw	nw	8	5	2	fair
10....	31.0	....	.00	0.0	e	w	w	2	3	6	fair
11....	33.8	......	.00	0.0	se	nw	w	2	2	8	fair
12....	14.1	.....	(r) T	0.0	w	sw	sw	4	6	1	fair
13....	19.0	.....	.00	0.0	ne	sw	sw	6	7	4	fair
14....	10.0	......	(r) T	0.0	s	s	s	6	7	8	fair
15 ..	16.0	.....	.00	0.0	ne	w	w	4	2	0	clear
16....	35.8	......	.00	0.0	e	sw	w	5	4	7	fair
17....	09.6	....	(r).03	0.0	nw	ne	w	10	10	4	cloudy
18....	33.3	......	.00	0.0	nw	sw	sw	4	2	2	clear
19....	18.2	......	.00	0.0	sw	sw	w	4	2	x	clear
20....	36.7	......	.00	0.0	e	e	n	x	0	0	clear
21....	39.1	......	.00	0.0	e	sw	....	0	x	0	clear
22....	37.9	......	.00	0.0	...	e	w	x	1	7	clear
23....	33.3	......	.00	0.0	e	sw	w	4	3	6	fair
24....	32.8	......	.00	0.0	w	w	w	1	6	7	fair
25....	29.6	......	.00	0.0	w	sw	w	2	3	0	clear
26....	30.8	.....	.00	0.0	...	sw	sw	0	3	1	clear
27....	17.3	...	.00	0.0	w	w	w	2	x	0	clear
28....	30.6	......	.00	0.0	...	w	w	0	x	x	clear
29....	22.6	....	.00	0.0	w	sw	nw	5	9	2	fair
30...	27.3	.....	.00	0.0	n	....	....	x	4	0	clear
......	....	......	.00	0.0	..	....	....	....	....	....	....
Sums	......	......	.11	0.0	...	....	...	....	....	....	....
Means	25.40	......	......	.....	w	sw	w	3.4	3.8	3.1	fair

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

20. Light dew.
21. Lunar corona.
22. Lunar halo at 20:00; brilliant corona at 24:00.
28. Killing frost.
29. Light frost.

RECORD FOR JULY.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.

Day of month.	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ⅓(7+2+9.)	Daily mean relative humidity ⅓(7+2+9.)	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.	Hum.	Temp.	Hum.	Temp.	Hum.				
1	52.7	44.9	77.3	10.5	67.0	21.4	66.00	25.60	81.1	41.4
2	28.5	30.7	83.4	19.6	72.2	27.4	71.58	25.90	85.8	46.3
3	63.0	46.8	86.0	16.0	74.3	25.4	74.46	29.40	88.1	52.6
4	62.7	52.3	87.8	16.6	72.9	32.3	74.08	33.73	90.1	54.0
5	66.8	47.0	83.4	17.6	69.9	19.8	72.50	28.15	85.4	57.1
6	62.7	51.5	83.9	9.2	70.0	24.0	71.65	28.23	85.2	52.7
7	61.7	41.9	85.9	11.2	69.9	19.2	71.85	24.10	88.1	50.2
8	58.5	53.5	88.8	2.2	70.9	19.3	72.28	25.00	89.9	48.2
9	66.8	32.8	83.9	9.2	64.0	22.2	69.68	21.40	86.6	48.8
10	57.7	43.7	79.5	8.9	61.3	72.1	64.95	41.57	83.8	40.6
11	54.8	89.2	63.7	39.5	53.7	28.7	56.48	52.47	66.0	53.2
12	52.7	31.5	70.7	20.6	59.8	38.0	60.75	30.03	72.0	41.1
13	53.8	65.0	82.3	17.3	66.8	33.6	67.42	38.63	82.4	44.6
14	58.7	18.0	81.1	21.7	67.4	25.6	68.65	21.77	83.5	48.7
15	61.7	38.1	87.0	13.2	75.9	60.2	75.12	22.50	88.3	49.1
16	64.6	45.2	90.0	13.2	73.0	41.0	75.15	33.13	92.1	53.7
17	59.7	75.0	88.1	13.3	67.8	45.4	70.85	44.57	90.1	56.1
18	64.7	59.1	89.8	10.4	75.1	30.6	76.18	33.37	92.5	54.6
19	63.5	67.0	87.8	18.2	68.9	47.3	72.28	44.17	89.3	59.7
20	65.7	71.9	87.8	23.2	75.7	35.3	76.23	43.47	91.3	57.7
21	69.9	57.0	83.9	23.3	69.2	58.8	73.05	46.37	84.1	62.3
22	64.9	72.0	81.9	34.1	68.8	59.6	71.10	55.23	87.1	58.0
23	62.7	29.9	87.4	35.0	75.9	48.5	75.48	37.80	88.5	55.7
24	68.6	60.6	88.0	22.0	72.3	14.1	75.30	32.23	89.2	59.5
25	59.7	44.9	83.5	7.9	68.8	10.8	70.20	21.20	85.5	51.6
26	57.7	54.1	82.7	8.6	59.7	34.9	64.95	32.53	84.0	46.1
27	55.0	51.0	82.9	8.2	69.9	16.1	69.43	25.10	84.1	44.6
28	58.3	50.5	82.9	5.3	67.3	15.3	68.95	23.70	84.0	48.9
29	55.7	41.9	82.9	11.7	74.9	14.0	72.10	22.53	85.2	44.6
30	60.8	46.6	84.4	11.8	73.0	26.2	72.80	28.20	87.0	56.7
31	67.6	27.8	78.3	15.4	62.7	18.3	67.83	20.50	81.0	61.6
Sums	....	.....	......	.....	......	.....	.....	.....	......	......
Means	61.03	49.72	83.45	15.96	69.00	30.37	70.62	.....	85.53	51.61

REMARKS:

16. Thunder and lightning W; lightning N at 21:00.
17. Thunder E at 13:30; lightning N at 21:00.
19. Thunder 11:30 SW; thunder and lightning SW at 16:30.
21. Lightning E at 21:00

RECORD FOR JULY.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian Time.

Day of month	Range of temperature	Daily mean barometer ⅓(7+2+9.)	Precipitation in inches	Snow in inches	WIND.			WEATHER.			
					Direction from.			Cloud proportion (scale 0-10.)			State.
					7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	
1	39 7	...	.00	0.0	....	....	....	....	....	...	clear
2	39.5	......	.00	0.0	....	s	w	9	8	0	fair
3	35.5	.....	.00	0.0	se	sw	nw	0	0	0	clear
4	36.1	......	.00	0.0	se	s	w	0	0	0	clear
5	28.3	.....	.00	0.0	se	w	se	1	1	2	clear
6	32.5	......	.00	0.0	nw	sw	sw	0	2	x	clear
7	37.9	......	.00	0.0	nw	sw	w	0	0	0	clear
8	41.7	......	.00	0.0	e	s	sw	0	0	0	clear
9	37.8	......	.00	0.0	ne	w	nw	0	0	0	clear
10	43.2	.....	(r).06	0.0	se	sw	e	x	7	10	fair
11	12.8	......	(r).04	0.0	sw	w	w	10	7	1	fair
12	30.9	......	.00	0.0	w	n	n	1	x	0	clear
13	37.8	.....	.00	0.0	sw	n	nw	0	1	1	clear
14	34.8	......	.00	0.0	sw	se	sw	0	x	0	clear
15	39.2	.....	.00	0.0	e	e	w	0	x	0	clear
16	38.4	......	(r).11	0.0	e	e	w	x	3	7	fair
17	34.0	.....	.03	0.0	w	w	sw	5	6	4	fair
18	37.9	......	.00	0.0	w	ne	nw	x	6	1	fair
19	29.6	.....	(r).17	0.0	sw	sw	w	8	4	4	fair
20	33.6	......	(r) T	0.0	e	sw	w	1	5	8	fair
21	21.8	.....	(r) T	0.0	ne	s	ne	6	8	7	fair
22	29.1	.....	.00	0.0	sw	sw	s	2	6	4	fair
23	32.8	......	(r).02	0.0	e	e	w	x	6	2	clear
24	29.7	.....	(r).02	0.0	e	w	w	0	4	x	clear
25	33.9	......	.00	0.0	sw	sw	w	1	x	1	clear
26	37.9	.....	.00	0.0	e	sw	w	0	x	0	clear
27	39.5	....	.00	0.0	e	sw	w	0	x	0	clear
28	35.1	......	.00	0.0	e	sw	w	0	x	0	clear
29	40.6	....	.00	0.0	w	sw	w	0	2	6	clear
30	30.3	......	(r) T	0 0	....	sw	nw	6	5	5	fair
31	19.4	.....	.00	0.0	w	sw	w	6	4	0	fair
Sums	.....	.....	.45	0.0	...	....	....	...	....	....	....
Means	33.92	.....	......	....	e	sw	w	1.9	2.8	2.2	clear

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

22. Thunder W at 10:15; thunder and lightning S at 14:00.
23. Lightning S at 20:30.
24. Thunder SW at 11:15 and 12:10, and NW at 13:00.

RECORD FOR AUGUST.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.

Day of month........	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.)........	Daily mean relative humidity ⅓(7+2+9.)....	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.....	Hum......	Temp.	Hum	Temp.....	Hum.. .				
1....	49.7	52.3	73.3	10.9	62.7	19.1	62.10	27.43	78.0	41.2
2....	52.7	43.7	75.3	16.5	63.9	30.7	63.95	30.30	77.6	42.5
3....	55.9	44.5	80.9	11.2	65.7	29.7	67.05	28.47	82.0	45.6
4....	56.7	56.1	81.1	13.8	67.8	31.6	68.35	33.83	81.1	47 6
5....	57.7	54.5	83.9	22.1	70.3	25.5	70.55	34.03	84.6	48.9
6....	58.7	58.5	86.3	17.7	75.6	22.9	74.05	33.03	88.3	50.0
7....	61.1	53.7	90.8	21.2	77.3	16.9	76.60	30.60	91.1	58.4
8....	60.8	48.8	86.4	13.2	76.9	16.7	75.25	26.23	89.0	52.4
9....	60.3	51.5	88.0	5.2	74.9	9.5	74.53	22.07	89.4	54.5
10....	59.7	38.3	87.8	7.6	73.0	15.1	73.38	20.33	89.1	55.7
11....	66.9	12.1	91.1	13.3	76.0	12.5	77.50	12.63	92.2	46.8
12....	60.9	40.7	92.0	12.6	75.6	13.2	76.03	22.17	92.1	51.8
13....	60.3	45.9	89.5	4.3	72.0	15.9	73.45	22.03	89.5	50.9
14....	56.2	44.8	86.3	6.9	71.5	22.3	71.08	24.67	87.0	48.6
15....	58.0	47.2	81.1	21.1	70.5	24.9	70.03	31.07	82.0	50.8
16 ...	61.5	43.7	80.0	20.6	59.8	54.4	65.28	39.57	82.2	54 5
17....	51.3	83.4	79.3	25.0	67.1	39.1	66.20	49.17	80.0	45.8
18 ...	55.2	66.2	84.7	15.6	70.2	37.4	70.08	39.73	84.4	48.7
19....	65.3	45.1	86.9	17 9	73.0	36.6	74.55	33.20	88.1	53.5
20....	60.8	60.4	80.0	15.6	74.5	22.6	72.45	32 87	88.7	53.5
21 ...	59.8	55.4	90.0	22.6	77.3	20.3	76.10	32.77	90.7	51.2
22....	60.5	48.9	91.6	11.0	75.7	19.9	75.88	26.60	92 1	52.6
23....	61.0	43.2	91.3	15.1	76.3	27.7	76.22	28.67	93.1	51.7
24....	60.9	37.9	91.1	11.5	75.2	15.5	75.60	21.63	92.6	54.6
25...	58.7	51.7	87.5	10.1	76.1	14.1	74.60	25.30	91.6	45.7
26....	62.9	40.7	84.1	14.9	70.2	19.3	71.85	24.97	81.1	55.7
27....	55.6	52.2	87.5	16.5	70.8	20.4	71.18	29.70	89.4	47.0
28....	58.2	49.6	92.2	19.6	77.1	19.8	76.15	29.67	92.0	52.6
29....	61.1	52.2	88.1	11.5	76.3	24.7	75.45	29.47	91 9	55.9
30....	70.3	43.1	73.9	77.9	61.6	68.6	66.85	63.10	79.0	60.7
31....	55.3	81.4	85.3	19.7	71.1	34.1	70.70	45.07	86.1	47.9
Sums.	....	......	......	.....	......	......	.....	.....	......	......
Means	59.16	49.93	85.39	16.85	71.81	25.19	72.04	30.65	86.97	50.88

REMARKS:

14. Light dew.
16. Thunder SW at 14:25.
20. Thunder SW at 13:30; lightning NW at 20:20.

RECORD FOR AUGUST.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian Time.

Day of month.........	Range of temperature...	Daily mean barometer ⅓(7+2+9.).........	Precipitation in inches..	Snow in inches........	WIND. Direction from. 7 A. M...	WIND. Direction from. 2 P. M...	WIND. Direction from. 9 P. M...	WEATHER. Cloud proportion (scale 0-10.) 7 A. M...	WEATHER. Cloud proportion (scale 0-10.) 2 P. M...	WEATHER. Cloud proportion (scale 0-10.) 9 P. M...	WEATHER. State.
1 ...	36.8	......	.00	0.0	e	sw	w	0	2	2	clear
2....	35.1	......	.00	0.0	sw	sw	sw	0	x	x	clear
3....	36.4	......	.00	0.0	e	sw	w	0	x	0	clear
4....	33.5	......	.00	0.0	sw	sw	sw	0	x	0	clear
5....	35.7	......	.00	0.0	sw	e	w	0	x	0	clear
6 ...	38.3	......	.00	0.0	...	se	w	0	0	0	clear
7...	32.7	......	.00	0.0	ne	e	w	1	3	1	clear
8....	36.6	......	.00	0.0	....	w	w	2	4	5	fair
9....	34.9	......	.00	0.0	w	sw	w	3	1	x	clear
10....	33.4	......	.00	0.0	ne	sw	sw	0	0	0	clear
11....	45.4	......	.00	0.0	e	se	w	x	2	1	clear
12....	40.3	......	.00	0.0	e	e	w	x	1	0	clear
13 ...	38.6	......	.00	0.0	e	sw	w	0	0	0	clear
14....	38.4	......	.00	0.0	...	sw	sw	0	x	1	clear
15 ...	31.2	......	.00	0.0	w	sw	w	x	3	1	clear
16....	27.2	......	(r).25	0.0	sw	e	nw	3	5	6	fair
17....	34.2	......	.00	0.0	w	sw	sw	x	3	2	clear
18....	35.9	......	.00	0.0	...	e	w	x	2	x	clear
19....	34.6	......	.00	0.0	sw	sw	w	0	2	3	clear
20....	35.2	......	.00	0.0	sw	se	w	x	3	x	clear
21....	39.5	......	.00	0.0	...	se	w	0	1	0	clear
22....	39.5	......	.00	0.0	e	e	nw	0	1	0	clear
23....	41.4	......	.00	0.0	e	sw	w	x	1	x	clear
24....	38.0	......	.00	0.0	e	sw	nw	2	x	0	clear
25....	45.9	......	.00	0.0	e	w	w	0	1	0	clear
26....	25.4	......	.00	0.0	e	w	w	0	x	0	clear
27....	42.4	......	.00	0.0	e	e	w	1	x	0	clear
28....	39.4	......	.00	0.0	e	e	w	0	2	0	clear
29....	36.0	......	.00	0.0	e	w	w	1	3	5	clear
30....	18.3	......	(r).02	0.0	ne	se	sw	8	9	2	fair
31....	38.2	......	.00	0.0	e	e	w	1	2	1	clear
Sums	......	......	.27	0.0	....	....	....	....	....	....	....
Means	36.09	......	....	......	e	sw	w	.7	1.7	1.0	clear

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

21. Light dew.
30. Lightning N at 21:00.
31. Heavy dew. The atmosphere smoky throughout the whole of the month.

RECORD FOR SEPTEMBER.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.

Day of month........	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.)........	Daily mean relative humidity ⅓(7+2+9.)....	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.....	Hum.....	Temp.....	Hum.....	Temp.....	Hum... .				
1....	60.8	61.8	87.1	19.1	74.2	28.6	74.08	36.50	89.1	55.4
2....	60.9	54.3	89.2	10.4	76.1	22.1	75.58	28 93	91.1	53.9
3....	58.4	53.0	90.2	31.2	78.2	19.8	76.25	31.33	93.0	53.5
4....	59.2	45 6	83.6	8.9	72.0	18.6	71.70	24.37	85 4	43.8
5....	55.3	51.3	81.0	19.4	67.0	15.8	67.58	28.83	82.0	49.0
6 ...	51.8	56.8	82.7	11.5	73.0	12.4	70.13	26.90	83.0	45.7
7....	56.2	50.0	87.1	8.0	75.9	16.8	73.78	24.97	89.2	47.7
8....	57.8	51.8	87.3	12.3	70.3	28.1	71.43	30.73	88.9	54.3
9....	64.0	56.0	70.0	43.6	58.8	64.2	62.90	54.60	85.0	52.5
10 ...	51.7	82.2	85.7	17.7	64.9	38.9	66.80	46.27	87.2	45.8
11....	61.2	49.2	86.1	11.1	70.0	40.4	71.83	33.57	88.4	56.3
12....	67.2	46.0	70.3	43.9	68.2	34.2	68.48	41.37	84.9	59.6
13....	55.7	71.3	88.3	18.3	74.0	32.2	73.00	40.60	87.8	51.6
14....	65.0	64.2	85.7	29.7	63.7	63.5	69.53	52.47	86.3	56.6
15....	60.2	84.6	65.7	79.4	60.6	70.6	61.78	78.20	84.1	56.2
16 ...	56.6	87.4	80.0	29.6	66.2	56.0	67.33	57.67	81 8	52.6
17....	53.4	79.0	74.8	16.3	60.0	35.8	62.05	43.70	76.2	50.5
18 ...	48.7	69.1	74.0	26 8	57.8	47.6	59.58	47.83	74.2	42.5
19....	50.8	63.6	78.9	19.8	67.7	39.3	66.28	40.90	81.1	42.5
20...	53.9	69.2	81.4	10.8	61.7	43.1	64.68	41.03	82.0	48.5
21 ...	49.7	60.1	81.9	9.6	67.0	22.8	66.40	30 83	82.2	44.9
22....	47.5	56.3	72.6	22.2	67.0	37.8	63.53	38.77	75.0	43.0
23....	58.5	36.9	59.6	71.0	54.8	97.0	56.93	68.30	67.1	52.0
24....	47.8	98.0	78.9	35.1	61.8	51.0	62.58	61.37	78.0	43.5
25....	54.5	73.0	84.8	19.8	68.8	44.4	69.23	45.73	86.1	46 5
26....	58.4	75.6	77.7	27.6	69.9	36.7	68.98	46.67	82.4	56 7
27....	55.8	72.0	80.2	25.9	71.4	40.2	69.70	46.03	83.1	50.9
28....	54.9	82.6	81.9	24.0	63.6	52.6	66.00	53.07	82.2	52.1
29....	53.3	81.8	78.2	20.3	68.0	28.6	66.88	43.57	79.1	42.4
30....	59.0	32.2	68.5	15.2	53.8	44.2	58.78	30.53	68.8	53.6
......	....	....	....	....	....	....	.....	.....	...	....
Sums.	......	......	......	.....	......	......	.....	......	......	.....
Means	56.28	63.83	79.78	24.62	66.88	39.11	67.46	42.52	82.82	50.14

REMARKS:

6. Light dew.
7. Light dew.
9. Thunder SW at 12:00.
10. Very heavy dew.
11. Light dew.
12. Thunder W at 12:45.
13. Heavy dew; lightning S at 18:00.
14. Thunder S at 16:58, also W.
15. Heavy dew; thunder S at 12:00, also S and SW at 13:50.
16 Heavy dew.

RECORD FOR SEPTEMBER.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian Time.

Day of month........	Range of temperature..	Daily mean barometer ⅓(7+2+9.)........	Precipitation in inches..	Snow in inches........	WIND.			WEATHER.			
					Direction from.			Cloud proportion (scale 0-10.)			State.
					7 A. M....	2 P. M...	9 P. M...	7 A. M...	2 P. M..	9 P. M..	
1....	33 7	....	.00	0.0	ne	se	w	0	2	0	clear
2...	37.2	......	.00	0.0	....	sw	w	0	1	0	clear
3....	39.5	......	.00	0.0	w	w	w	0	x	x	clear
4....	41.6	......	.00	0.0	sw	sw	sw	1	2	x	clear
5....	33.0	......	.00	0.0	sw	ne	nw	0	x	0	clear
6 ...	37.3	......	.00	0.0	...	ne	w	0	x	0	clear
7...	41.5	......	.00	0.0	sw	w	w	0	x	0	clear
8....	34.6	......	T	0.0	....	s	sw	1	2	x	clear
9....	32.5	......	.15	0.0	e	n	w	5	7	x	fair
10....	41.4	....	.00	0.0	w	e	w	x	5	1	clear
11....	32.1	......	T	0.0	sw	sw	w	2	5	6	fair
12....	25.3	......	T	0.0	e	w	n	2	7	3	fair
13....	36.2	......	.00	0.0	w	e	sw	1	2	5	clear
14....	29.7	......	.22	0.0	sw	sw	nw	2	5	6	fair
15....	27.9	.....	.21	0.0	w	nw	sw	2	8	5	fair
16....	29.2	......	.00	0.0	w	sw	w	x	2	x	clear
17....	25.7	......	.00	0.0	nw	sw	n	5	3	x	clear
18....	31.6	......	.00	0.0	w	e	e	x	x	x	clear
19....	38.6	......	.00	0.0	e	w	nw	x	x	0	clear
20....	33.5	......	.00	0.0	e	sw	sw	0	0	0	clear
21....	37.3	......	.00	0.0	e	sw	w	0	0	0	clear
22....	32.0	......	T	0.0	w	n	s	0	2	8	fair
23....	15.1	......	.09	0.0	ne	sw	w	5	9	5	fair
24....	34.5	......	.00	0.0	e	e	sw	x	x	x	clear
25....	39.6	......	.00	0.0	e	e	se	1	2	1	clear
26....	25.7	......	T	0.0	w	sw	e	3	5	4	fair
27....	32.2	.....	T	0.0	w	w	nw	x	2	5	clear
28....	30.1	......	T	0.0	e	e	ne	x	4	3	clear
29....	36.7	....	.00	0.0	sw	sw	sw	2	5	4	fair
30....	15.2	......	.03	0.0	w	sw	w	9	2	1	fair
......	....	......	....	...	....	....	....	....	....	....	....
Sums	......	......	.70	0.0	....	....	....	....	....	....	....
Means	32.68	......	....	.....	w	sw	w	1.4	2.7	2.0	clear

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

17. Heavy dew; lightning E at 18:45.
18, 20. Light dew.
24. Fog and dew.
25. Lightning S at 18:25.
26. Thunder SW at 13:07; lightning SE at 18:00.
27. Thunder and lightning SE at 20:50, NE at 21:30.
28. Thunder W at 12:40; thunder and lightning SE at 18:00.
29. Light dew.

RECORD FOR OCTOBER.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.

Day of month......	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.)......	Daily mean relative humidity ⅓(7+2+9.)....	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.....	Hum.....	Temp.....	Hum.....	Temp.....	Hum..				
1....	42.3	83.1	62.3	42.5	53.8	60.4	53.05	62.00	68.2	37.7
2....	47.0	73.6	66.8	42.6	60.9	49.1	58.90	55.10	69 0	43.4
3....	47.7	89.8	71.2	27.2	55.1	29.3	57.28	48.77	72.2	43.4
4....	44.3	73.5	76.7	20.9	58.8	47.8	59.65	47.40	75.9	40 3
5....	48.4	61.8	78.7	26.2	64.7	33.5	64.13	40.50	77.5	42.8
6....	50.8	71.6	73.1	19.1	58.0	37.0	59.98	42.57	73.3	47.6
7....	38.7	81.4	72.9	18.0	62.6	19.0	59.20	39.47	73.8	38.0
8....	49.3	44.1	68.8	31.8	55.9	63.2	57.48	46.37	70.3	45.0
9....	43.7	73.2	72.8	26.0	54.7	44.1	56.48	47.77	74.6	39.5
10....	45.6	56.0	76.8	20.7	58.1	37.5	59.65	38.07	77.9	40.3
11....	45.4	64.0	81.1	19.1	67.2	24.6	65.23	35.90	82.9	39.1
12....	40.9	55.0	75.5	09.6	61.8	21.6	60.00	28.73	78.2	40.5
13....	41.7	62.3	63.6	34.4	49.1	43.3	50.88	46.67	64.2	39.1
14....	35.2	70.6	61.8	39.6	49.8	34.6	49.15	48.27	68.0	32.9
15....	38.0	67.6	74.7	19.2	61.0	22.2	58.68	36.33	78.1	34.7
16 ..	42.5	58.0	71.8	13.2	58.9	25.1	58.03	32.10	73.4	36.8
17....	52.9	31.5	60.7	22.5	50.9	44.8	53.85	32.93	62.9	46.7
18 ...	34.8	81.0	63.0	20.6	46 8	22.4	47.85	41.33	62.9	34.0
19....	32.1	98.0	68.1	76.0	53.7	23.7	51.90	65.90	70.4	27.9
20....	33.9	66.1	61.0	28.2	47.8	42.6	47.63	45.63	62.3	31.6
21....	36 2	71.6	54.9	14.6	40.9	39.5	43.23	41.90	56 2	29.9
22....	29.1	88.0	62.0	28.4	43.9	50.7	44.73	55.70	63.3	27.3
23....	33.8	65.2	69.6	09.8	54.8	29.8	53.25	34.93	71.0	31.8
24....	49.0	42.0	56.9	26.7	45.1	35.9	49.03	34.87	60.4	45.6
25...	44.1	54.5	55.3	32.9	46.9	47.7	48.30	45.03	58.9	36.7
26....	32 1	75.1	60.5	21.5	44.3	33.1	45.30	43.23	61.1	29.5
27....	33.8	57.8	66.4	28.2	46.8	53.6	48.45	46.53	66.8	28.6
28....	37.0	73.0	71.8	18.7	53.9	33.1	54.15	41.60	73.4	34.4
29....	41.0	63.2	65.9	36.7	55.9	45.9	54.68	48.60	67.4	38.9
30....	39.5	73.9	60.9	28.9	54.1	41.5	52.15	48.10	61.4	37.1
31....	48.8	55.6	55.6	21.0	40.8	39.4	46.50	36.77	58.8	38.8
Sums.	......	......	.....	.....	......	......	.....	......	......	.....
Means	41.28	67.17	67.14	26.61	53.45	37.94	53.83	43.90	68.86	37.41

REMARKS:

1. Frost.
2. Light frost.
3. Dew; lightning NE at 20:00.
4. Light dew; smoky.
5. Light dew.
6. Lightning SE at 19:00.
7. Light dew.
9. Light frost.
10. Light frost.
11. Light frost.
12. Smoky; fires in foothills.
14. Frost and thin ice.

RECORD FOR OCTOBER.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian Time.

Day of month	Range of temperature	Daily mean barometer ⅓(7+2+9.)	Precipitation in inches	Snow in inches	WIND.			WEATHER.			
					Direction from.			Cloud proportion (scale 0-10.)			State.
					7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	
1...	30.5	.....	.00	0.0	e	ne	ne	1	4	3	clear
2...	25.6	.....	.00	0.0	w	ne	nw	2	3	2	clear
3...	28.8	.....	.00	0.0	e	sw	w	1	1	0	clear
4...	35.6	......	.00	0.0	e	e	w	0	x	0	clear
5...	34.7	.....	.00	0.0	e	e	sw	x	3	2	clear
6...	25.7	.....	(r) T	0.0	e	sw	w	1	2	x	clear
7...	35.8	.....	.00	0.0	ne	se	w	x	1	2	clear
8...	25.3	.....	.00	0.0	ne	sw	e	x	4	x	clear
9...	35.1	.....	.00	0.0	sw	e	sw	0	1	x	clear
10...	37.6	.....	.00	0.0	nw	e	w	x	1	0	clear
11...	43.8	.....	.00	0.0	w	e	w	1	x	0	clear
12...	37.7	.....	.00	0.0	e	sw	e	x	2	1	clear
13...	25.1	.....	.00	0.0	se	w	ne	x	1	x	clear
14...	35.1	.....	.00	0.0	w	e	nw	2	2	0	clear
15...	43.4	.....	.00	0.0	...	e	w	0	0	0	clear
16...	36.6	.....	.00	0.0	e	sw	w	0	1	x	clear
17...	16.2	.....	.00	0.0	sw	n	n	3	3	x	clear
18...	28.9	.....	.00	0.0	w	e	n	0	x	0	clear
19...	42.5	.....	.00	0.0	w	e	n	1	3	1	clear
20...	30.7	.....	.00	0.0	w	n	n	x	0	x	clear
21...	26.3	.....	.00	0.0	ne	n	w	x	0	x	clear
22...	36.0	.....	.00	0.0	nw	ne	w	2	3	2	clear
23...	39.2	.....	.00	0.0	e	sw	sw	2	1	2	clear
24...	14.8	.....	.00	0.0	n	nw	sw	6	2	2	fair
25...	22.2	......	(r) T	0.0	e	w	nw	8	6	x	fair
26...	31.6	.....	.00	0.0	w	se	nw	1	x	0	clear
27...	38.2	.....	.00	0.0	sw	....	n	0	x	0	clear
28...	39.0	......	.00	0.0	....	s	w	0	0	x	clear
29...	28.5	.....	.00	0.0	s	e	w	9	3	x	fair
30...	24.3	.....	.00	0.0	nw	s	w	6	9	7	fair
31...	20.0	.....	.00	0.0	w	sw	n	6	4	x	fair
Sums	.....	.....	T	0.0	....	....	....	....	....	....	....
Means	31.45	.....	....	......	e	e	w	1.7	1.8	0.8	clear

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

15. Frost and thin ice.
18. Frost and thin ice.
19. Frost; ice ¼ inch.
20. Frost; thin ice.
21. Frost; ice 3-16 inch.
22. Frost and thin ice.
23. Frost and thin ice.
24. Hazy.
26. Frost and thin ice.
27. Frost and ice; smoky.
28. Frost.
30. Frost.

RECORD FOR NOVEMBER.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.

Day of month......	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.).......	Daily mean relative humidity ⅓(7+2+9.)....	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.....	Hum......	Temp.....	Hum......	Temp.....	Hum...				
1....	26.9	80.5	59 5	14.8	40.8	41.0	41.75	45.43	55.2	23.7
2....	31.8	63.8	68.5	64.6	56.8	28.4	53.48	52.27	69.1	28 7
3....	49.8	54.8	39.3	92.8	35.8	95.0	40.10	80.87	56.9	34.0
4....	34.5	86.5	45.1	51.9	31.1	90.0	35.45	76.13	47.2	50.6
5....	23.7	67.3	46.6	44.4	29.8	40.6	32.48	50.77	46.5	22.4
6....	28.9	47.9	45.9	41.2	39.3	58.3	38.35	49.13	48 3	25.7
7....	26.1	42.1	48.6	44.0	35.8	58.8	36.58	48.30	48.1	26.2
8....	28.8	91.4	53.5	25.6	32.2	70.2	36.68	62.40	52.1	26.2
9....	24.8	55 5	54.6	30.2	34.0	71.0	36.85	52.23	56.2	22.3
10 ...	27.8	36.4	56.9	37.3	38.8	52.0	40.58	41.90	57.1	25.1
11....	27.5	52.0	56.9	35.8	41.9	48.1	42.05	45.30	57.8	24.6
12....	24.9	53.3	61.1	09.6	48.1	29.1	45.63	30.67	62.1	24.4
13....	35.9	66.5	61.9	29.5	44.3	54.7	46.60	50.23	61.1	32.1
14....	37.9	64.3	45.9	59.7	41.0	60.8	41.45	61.60	47.2	34.3
15....	38.8	69.2	48.6	38.6	44.3	54.7	44.00	54.17	50.1	35.8
16....	38.0	98.0	43.9	91.2	39.7	98.0	40.33	95.73	45.0	36.6
17....	31.9	100.0	47.0	69.0	42.8	82.4	41.13	83.80	45.3	31.7
18 ...	34.7	94.2	48.9	74.8	41 0	97.6	41.40	88.87	48.9	33.9
19....	31.8	87.6	54.5	58.4	37.9	76.5	40.53	74.17	53.8	39.5
20....	37.0	78.8	45.5	80.4	39 9	93.6	40.57	84.27	45.7	32.8
21....	43.5	66.8	49.8	63.2	38.3	81.4	42.47	70.47	52 1	38.3
22....	36.5	79.0	48.5	61.2	40.5	80.8	40.50	73.66	48.4	33.1
23....	39.8	70.2	43.6	74.0	38.7	45.9	40.20	63.37	48.6	32.8
24....	36.5	57.5	53.5	50.1	41.6	62.2	43.30	56.60	52.8	27.9
25....	30.9	81.0	56.8	49.4	49.2	40.4	46.52	56.93	55.1	29.4
26....	40 9	84.0	44.5	43.9	38.3	48.7	41.50	58.87	50.1	35.9
27....	27.3	73.3	42.4	36.2	24.8	68.4	29.82	59.30	43.1	25.4
28....	18.8	76.0	44.3	29.6	27.3	86.6	29.42	64.07	44.3	18.3
29....	17.0	70.8	42.6	39.0	27.2	42.4	28.50	50.73	43.7	17.0
30....	22.8	63.6	51.3	47.9	35.9	72.1	36.47	61.20	49.1	21.4
......	....	....	....	....	....	....	.....	.....	....	....
Sums.	.....	....	....	.....	....	....	.....	.....	....	......
Means	31.85	70.41	50.33	49.61	38.57	64.32	39.82	61.48	51.36	29.00

REMARKS:

3. Snowing in mountains E and W.
4. Light hail storm; first snow in neighboring mountains E and W
5. Very heavy frost.
9. Lunar halo.
15. Snowing in mountains.
16. Rainbow in morning.
17. Dense fog.
18. Fog; snowing in hills.

RECORD FOR NOVEMBER.

RENO, NEVADA.

ALTITUDE, 4,552 feet; 120th W. Meridian Time.

Day of month.......	Range of temperature...	Daily mean barometer ⅓(7+2+9.).........	Precipitation in inches...	Snow in inches	WIND.			WEATHER.			
					Direction from.			Cloud proportion (scale 0-10.)			State.
					7 A. M...	2 P. M...	9 P. M...	7 A. M...	2 P. M...	9 P. M...	
1....	31.5	25.611	.00	0.0	nw	se	n	....	....	0	clear
2....	40.4	25.560	.00	0.0	nw	e	w	....	3	1	clear
3....	22.9	25.449	(r).46	0.0	w	n	sw	8	10	10	cloudy
4....	16.6	25.428	(r&b) T	0.0	nw	nw	n	5	3	0	clear
5....	24.1	25.605	.00	0.0	nw	ne	nw	....	....	0	clear
6 ...	22.6	25.548	.00	0.0	n	sw	n	9	7	0	fair
7...	21.9	25.668	.00	0.0	n	e	n	3	1	0	clear
8....	25.9	25.661	.00	0.0	nw	ne	w	0	0	0	clear
9....	33.9	25.557	.00	0.0	ne	nw	nw	....	2	1	clear
10....	32.0	25.463	.00	0.0	nw	ne	nw	2	3	....	clear
11....	33.2	25.410	.00	0.0	ne	....	n	0	0	0	clear
12....	37.7	25.419	.00	0.0	n	sw	w	1	3	....	clear
13....	29.0	25.434	.00	0.0	w	s	sw	4	8	3	fair
14....	12.9	25.387	.00	0.0	w	ne	ne	8	7	8	cloudy
15....	14.3	25.314	(r).05	0.0	nw	e	e	10	10	10	cloudy
16....	8.4	25.230	(r).16	0.0	sw	sw	sw	9	8	5	cloudy
17....	13.6	25.313	....	0.0	sw	w	ne	7	9	10	cloudy
18....	15.0	25.484	(r).69	0.0	w	e	w	9	3	3	fair
19....	14.3	25.611	.00	0.0	se	e	w	4	1	2	clear
20....	12.9	25.494	(r).33	0.0	se	w	w	6	10	9	cloudy
21....	13.8	25.537	(r).03	0.0	w	sw	e	9	6	1	fair
22....	15.3	25.259	(r) T	0.0	sw	e	w	6	9	9	cloudy
23....	15.8	25.301	(r).18	0.0	n	sw	nw	10	8	1	fair
24....	24.9	25.450	.00	0.0	e	e	w	....	....	0	clear
25....	25.7	25.314	.00	0.0	ne	sw	w	....	3	5	clear
26....	14.2	25 434	(r).05	0.0	nw	ne	n	8	8	1	fair
27....	17 7	25.617	.00	0.0	n	e	n	....	....	0	clear
28....	26.0	25.594	.00	0.0	n	e	nw	0	....	0	clear
29....	26.7	25.504	.00	0.0	nw	ne	nw	1	2	0	clear
30....	27.7	25.490	.00	0.0	nw	ne	w	1	3	....	clear
......	....	......	....	...	...	...	...	...	...	...	....
Sums	......	......	1.95	0.0	....	....	....	....	....	....	....
Means	22.36	25.472	....	......	nw	e	w	4.0	4.2	2.6	clear

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

19. Heavy fog.
21. Lunar corona.
23. Snowing in mountains.
24. Fog.
25. Rainbow at 11:40.

Snow lying on mountains W since the 3d inst.

Snow lying in patches on mountains since the 15th inst.

RECORD FOR DECEMBER.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.

Day of month......	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9)......	Daily mean relative humidity ⅓(7+2+9)....	Maximum temperature.	Minimum temperature.
	7 A. M.		2 P. M.		9 P. M.					
	Temp.....	Hum......	Temp.....	Hum	Temp.....	Hum.. .				
1....	44.9	63.9	47.5	63.6	41.8	79.2	44.00	68.90	47.7	31.3
2 ...	29.1	36.2	51.1	67.4	36.3	53.7	38.20	52.43	52.9	26.1
3 ...	27.5	61.7	52.5	53.9	35.1	72.1	37.55	62.57	54.1	26.9
4....	25.4	60.2	51.4	55.2	32.3	83.0	35.35	66.13	50.5	24.9
5....	27.0	44.2	41.9	63.9	33.6	77.4	34.03	63.50	45.9	26.1
6 ...	25.3	52.3	51.8	42.8	36.3	74.9	37.42	56.67	52.1	24.4
7 ...	27.6	25.8	52.0	33.8	33.4	70.4	36.60	43.33	52.2	22.7
8....	25.8	45.6	65.1	18.2	46.5	31.2	44.23	31.67	59.7	23.6
9....	41.8	72.0	54.8	48.2	42.6	74.6	45.45	64.93	56.1	41.3
10 ...	32.8	91.0	52.8	11.4	38.5	44.1	40.65	48.83	54.9	32.6
11....	26.9	45.8	53.6	38.6	34.9	72.0	37.58	52.13	56.4	25.8
12....	25.8	63.0	54.7	25.0	48.8	15.4	44.52	36.13	56.4	24.9
13....	45.1	37.1	48.0	40.4	37.5	71.5	42.03	49.67	50.8	35.8
14....	30.5	51.5	39.8	36.6	31.8	92.0	33.48	60.03	50.7	30.6
15....	30.5	28.0	38.1	75.0	36.8	94.0	35.55	65.67	39.0	28.4
16 ...	46.8	59.4	51.8	46.2	41.8	71.2	45.55	58.93	53.1	36.3
17....	26.1	56.5	52.6	47.4	35.1	67.3	37.22	57.07	52.3	25.5
18 ...	22.9	63.7	48.8	47.2	30.1	89.6	32.98	66.66	48.6	23.3
19....	23.9	53.5	47.9	40.9	32.9	70.9	34.40	55.10	47.1	22.4
20....	29.8	74.8	40.9	33.0	38.6	67.4	36.97	58.40	44.1	27.3
21 ...	35.5	84.0	40.9	77.6	37.1	84.0	37.65	81.87	41.9	32.7
22....	35.1	97.5	41.4	84.8	38.1	92.0	38.17	91.43	41.9	35.4
23....	37.8	78.0	42.8	65.8	37.0	76.4	38.65	73.40	43.0	35.2
24....	29.8	60.8	40.7	63.7	33.9	80.1	34.57	68.20	42.0	27.9
25....	31.8	72.8	34.7	73.5	32.8	90.0	33.03	78.77	35.3	29.7
26....	31.8	83.8	36.0	94.0	34.0	98.0	33.95	91.93	37.8	29.8
27....	29.8	100.0	40.1	79.2	35.3	88.0	35.13	89.07	39.4	28.7
28....	29.8	89.6	42.2	57.2	30.5	92.6	33.25	79.80	43.5	29.0
29....	25.8	100.0	36.0	82.0	31.2	94.0	31.05	92.00	37.4	25.4
30....	30.3	93.8	32.8	92.0	28.1	56.1	29.83	80.63	33.1	28.3
31....	26.4	67.8	28.5	74.4	26.8	79.2	27.13	73.80	29.3	25.7
Sums.	.....	......	......	......	......	......	......	.....	......	......
Means	30.95	65.14	45.36	56.06	35.79	74.25	36.97	65.15	46.75	28.65

REMARKS:

4. Foggy.
7. Light frost; hazy at 21:00.
9. Snowing in mountains w.
12. Hazy at sunrise and sunset.
14. First snow of season; lunar halo.
17. Lunar halo.
19. Lunar halo.

RECORD FOR DECEMBER.

RENO, NEVADA.

Altitude, 4,552 feet; 120th W. Meridian Time.

Day of month	Range of temperature...	Daily mean barometer ⅓(7+2+9.).	Precipitation in inches...	Snow in inches	WIND. Direction from. 7 A. M...	2 P. M...	9 P. M...	WEATHER. Cloud proportion (scale 0-10.) 7 A. M...	2 P. M...	9 P. M...	State.
1....	16.4	25.537	(r).03	0.0	w	nw	nw	6	9	2	fair
2....	26.8	25.684	.00	0.0	w	e	nw	1	1	0	clear
3....	27.2	25.680	.00	0.0	w	w	w	0	1	0	clear
4....	25.6	25.606	.00	0.0	e	e	w	4	2	0	clear
5....	19.8	25.434	.00	0.0	w	se	w	6	5	0	fair
6 ...	27.7	25.387	.00	0.0	w	e	w	5	1	1	clear
7...	29.5	25.488	.00	0.0	w	se	w	2	1	1	clear
8....	36.1	25.463	.00	0.0	nw	s	w	1	3	4	clear
9....	14.8	25.490	(r) T	0.0	sw	w	nw	9	6	5	fair
10....	22.3	25.413	.00	0.0	w	w	w	9	5	1	fair
11....	30.6	25.461	.00	0.0	w	e	n	2	1	....	clear
12....	31.5	25.356	.00	0.0	w	sw	n	2	1	8	fair
13....	15.0	25.119	(r) T	0.0	se	s	n	3	3	8	fair
14....	20.1	25.243	.01	0.1	w	w	ne	1	8	8	fair
15....	10.6	25.474	.04	0.0	nw	ne	se	6	10	7	cloudy
16....	16.8	25.546	.00	0.0	w	sw	nw	3	2	3	clear
17....	20.8	25.692	.00	0.0	w	sw	w	3	4	2	clear
18....	25.3	25.643	.00	0.0	w	ne	sw	3	3	....	clear
19 ...	24.7	25.608	.00	0.0	nw	se	ne	3	3	4	fair
20....	16.8	25.550	.00	0.0	nw	e	ne	5	3	8	fair
21....	09.2	25.240	(r) T	0.0	sw	ne	w	9	10	10	cloudy
22....	06.5	25.192	(r).25	0.0	ne	sw	ne	10	10	10	cloudy
23....	07.8	25.064	(r).18	0.0	ne	nw	nw	8	8	....	fair
24....	14.1	25.333	(r).03	0.0	sw	ne	ne	5	4	8	fair
25....	05.6	25.362	.00	0.0	sw	sw	e	9	9	5	fair
26....	08.0	25 287	(r).16	1.5	e	se	w	10	8	4	fair
27....	10 7	25.450	.00	0.0	w	e	w	10	3	9	fair
28....	14.5	25.497	.00	0.0	ne	sw	ne	8	4	1	fair
29....	12.0	25.610	.00	0.0	w	se	e	9	9	10	cloudy
30...	04.8	25.721	.00	0.0	se	s	e	10	9	10	cloudy
31....	03.6	25.664	.00	0.0	e	e	e	10	10	9	cloudy
Sums	......	......	.70	1.6	....	....	....	....	....	....	....
Means	18.10	25.461	....	.....	w	e	w	5.9	5.0	4.4	fair

T=Trace of Precipitation; X=Inappreciable.

REMARKS:

22. Foggy in foot-hills.
24. Very heavy frost.
25. Foggy in mountains SW.
26. One inch of snow at 7:00.
27. Foggy.
31. Snowing in mountains.

PRECIPITATION AND WEATHER.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.; ALTITUDE, 4,552 feet,
120th W. Meridian Time.

MONTH.	Precipitation in inches	Snow in inches	WEATHER.				
			Number of				Prevailing
			Rainy days	Cloudy days	Fair days	Clear days	
January	1.72	3.7	8	17	6	8	cloudy
February	T	0.0	0	3	9	17	clear
March	.57	7.6	3	9	10	12	clear
April	.14	0.8	2	3	4	23	clear
May	.79	0.0	4	5	4	22	clear
June	.11	0 0	3	2	14	14	fair
July	.45	0.0	7	0	12	19	clear
August	.27	0.0	1	0	3	28	clear
September	.70	0.0	5	0	10	20	clear
October	T	0.0	0	0	5	26	clear
November	1.95	0.0	7	7	6	17	clear
December	.70	1.62	9	9	12	10	fair
Year	7.40	13.72	49	55	95	216	clear
Month Greatest	Nov. 1.95	Mar. 7.6	Dec. 9	Jan. 17	June 14	Aug. 28	....
Month Least	Fe&Oc T	....	Fe&Oc 0	Jy–Oc 0	Aug. 3	Jan. 8	....

DIRECTION OF WIND.

RENO, NEVADA.

LATITUDE, 39° 31′ 15″ N.; LONGITUDE, 119° 49′ W.; ALTITUDE, 4,552 feet; 120th W. Meridian Time.

TIME.		TIMES OBSERVED BLOWING FROM								Times calm	Prevailing
		N	NE	E	E	S	SW	W	W		
MAY	7 A. M	2	2	15	2	0	1	3	6	0	e
	2 P. M	2	4	8	0	0	8	7	2	0	e&sw
	9 P. M	1	0	1	0	0	3	15	10	1	w
	Total	5	6	24	2	0	12	25	18	1	w
JUNE	7 A. M	2	2	6	2	1	2	8	4	3	w
	2 P. M	1	3	2	0	1	12	9	1	1	sw
	9 P. M	2	0	0	0	1	4	18	3	2	w
	Total	5	5	8	2	3	18	35	8	6	w
JULY	7 A. M	0	2	9	4	0	6	5	2	2	e
	2 P. M	2	1	3	1	4	14	5	0	0	sw
	9 P. M	1	1	1	1	1	4	16	5	0	w
	Total	3	4	13	6	5	24	26	7	2	sw
AUG.	7 A. M	0	3	14	0	0	6	3	0	5	e
	2 P. M	0	0	9	5	0	13	4	0	0	sw
	9 P. M	0	0	0	0	0	6	22	3	0	w
	Total	0	3	23	5	0	25	29	3	5	w
SEPT.	7 A. M	0	2	8	0	0	6	10	1	3	w
	2 P. M	2	2	6	1	1	12	5	1	0	sw
	9 P. M	2	1	2	1	1	7	12	4	0	w
	Total	4	5	16	2	2	25	27	6	3	w
OCT.	7 A. M	2	3	9	1	1	3	7	3	2	e
	2 P. M	3	3	10	2	2	7	2	1	1	e
	9 P. M	6	2	2	0	0	4	13	4	0	w
	Total	11	8	21	3	3	14	22	8	3	w
NOV.	7 A. M	6	3	1	1	0	4	5	10	0	nw
	2 P. M	1	7	9	1	1	6	2	2	1	e
	9 P. M	7	2	2	0	0	3	10	6	0	w
	Total	4	12	12	2	1	13	17	18	1	w
DEC.	7 A. M	0	3	3	2	0	4	15	4	0	w
	2 P. M	0	4	7	5	3	6	4	2	0	e
	9 P. M	3	6	4	1	0	1	11	5	0	w
	Total	3	13	14	8	3	11	30	11	0	w
MAY to DEC. Total	7 A. M	12	20	65	12	2	32	56	39	15	e
	2 P. M	11	24	54	15	12	78	38	9	3	sw
	9 P. M	22	12	12	3	3	32	117	40	3	w
	Total	45	56	131	30	17	142	211	79	21	w

COMPARATIVE TABLE,

TEMPERATURE AND PRECIPITATION,

Of Reno, Carson City and Winnemucca, Nevada.

	RENO.	CARSON CITY.		WINNE-MUCCA.
	1888.	1888.	† Normal.	1888.
Highest temperature	93.1	96.2	97.9	96.0
Lowest temperature	-12.7	-12.0	-4.7	—28.0
Annual range of temperature	105.8	108.2	103.0	124.0
Mean temperature	*51.4	50.7	49 81	50.6
Mean daily range of temperature	30.5	33.4	32.2	28.5
Annual precipitation	7.40	7.12	10.82	4.89

* ½(Mean Max.+Mean Min) † Nine Years Observation.

VT STATION FOR 1888.

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. Meridian Time.

AN. ean Min.)			Daily Range.					Total Monthly Range.
Date	Mean	Monthly range	Greatest	Date	Least	Date	Mean	
4	27.43	51.70	35.0	9	14.5	20	25.69	76.1
0	42.96	17.80	50.2	28	13.9	10	36.16	61.9
1	43.42	31.85	59.0	13	15.0	4	35.43	74.3
5	54.16	23.55	50.5	7	16.0	25	39.55	67.0
4	55.48	21.10	46.9	13	10.0	25	29.47	60.8
7	58.87	17 55	39.1	21	10.0	14	25.40	49.3
2	68.57	17.80	43.2	10	21.8	21	33.92	51.9
1	68.92	15.15	45.9	25	18.3	30	36.09	51.9
3	66.48	14.95	41.6	4	15.1	23	32.68	50.6
1	53.14	17.95	43.8	11	14.8	24	31.45	55.6
9	40.18	18.55	40.4	2	8.4	16	22.36	52.1
1	37.70	21.70	36.1	8	3.6	31	18.10	37.3
	51.44	22.47	44.31		13.45		30.53	57.40
ug.	Aug. 68.92	Jan. 51.70	59.0	Mar. 13	21.8	July 21	Apr. 39.55	Jan. 76.1
n. 4	Jan. 27.43	Sept 14.95	35.0	Jan. 9	3.6	Dec. 31	Dec. 18.10	Dec. 37.3

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Nevada Agricultural

EXPERIMENT STATION,

Bulletin No. 4,

March, 1889.

METEOROLOGICAL REPORT

FOR

January, February and March, 1889,

BY

WALTER McN. MILLER, B. Sc.

RENO:
STATE JOURNAL OFFICE PRINT.
1889.

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H. K. CLAPP, A. M., Reno,	Librarian.
Reno,	Sup't of Field Experiments.
S. G. KENDALL, Reno,	Janitor.

METEOROLOGICAL REPORT

FOR

January, February and March, 1889.

The Nevada Agricultural Experiment Station is located on the farm of the State University, Reno, Washoe County, Nevada, in the approximate latitude of 39° 31′ 15″ N., and longitude 119° 49′ W. The height of the ground above the sea level is about 4,552 feet; the cistern of the barometer is twelve feet above the ground, 4,564 feet above the sea; the thermometers are in a well constructed shelter over alfalfa sod, fifteen feet above the surface; the rain guage is in an open field and is two feet above the ground.

All the instruments used were made by Henry J. Green, of New York, and all are provided with certificates for correcting instrumental error.

Weather observations at the Station were begun April 14th, 1888. Data of 1888 taken prior to that date and used in the following tables for comparison, were given the Station by Mr. C. M. Fassett, who was at that time acting as observer for the State Weather Service. The only instruments used by him were the maximum and minimum thermometers and a rain guage.

The shelter then used was small and was unfavorably situated among the buildings of Reno, and was fifty feet below the one that is now in use.

In the following tables the barometer readings have been corrected for temperature, but have not been reduced to the sea level. Also no corrections for air pressure have been applied in determining the dew point and relative humidity.

Corrections for instrumental error were made in all readings.

WALTER McN. MILLER,
Botanist, Chemist and Weather Observer.

RECORD FOR JANUARY.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

Day of Month.	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼ (7+2+9+9)…	Daily mean relative humidity ⅓ (7+2+9)……	Maximum Temperature….	Minimum temperature….
	7 A. M.		2 P. M.		9 P. M.					
	Temp……	Hum……	Temp……	Hum……	Temp……	Hum……				
1…………	24.7	68.3	28.7	61.7	18.5	64.5	22.60	64.83	32.2	18.6
2…………	16.1	85.5	35.4	72.4	26.8	45.6	26.28	67.83	37.1	15.8
3…………	23.8	67.4	40.1	50.5	30.8	72.8	31.37	63.57	41.0	21.6
4…………	27.5	52.0	33.2	86.0	22.9	63.7	26.63	67.23	36.1	23.4
5…………	20.9	61.7	39.6	49.2	26.9	45.8	28.58	52.23	41.2	17.6
6…………	19.9	74.0	44.4	34.8	27.1	68.4	29.62	59.07	45.1	19.2
7…………	19.8	74.0	45.3	44.3	31.8	63.8	32.18	60.70	45.0	19.4
8…………	22.8	66.4	44.1	50.9	37.3	62.1	35.38	59.80	45.0	17.6
9…………	31.6	53.2	51.8	15.8	36.4	61.2	39.05	43.40	52.9	26.6
10…………	22.0	74.4	41.7	47.9	40.3	49.1	36.07	57.13	49.1	20.7
11…………	28.0	80.0	46.8	19.2	31.8	63.8	34.60	54.33	47.9	26.9
12…………	20.9	67.3	42.7	30.5	28.3	34.0	30.05	43.93	44.7	19.1
13…………	16.2	72.7	38.0	89.0	31.4	49.8	29.25	70.50	38.7	14.9
14…………	26.3	78.7	32.9	73.0	26.5	88.8	28.05	80.17	33.1	25.4
15…………	15.6	64.2	36.8	57.8	24.8	55.6	25.50	59.20	39.0	14.6
16…………	11.2	85.0	33.1	80.1	17.0	70.5	19.58	78.53	33.4	10.9
17…………	15.8	57.8	38.8	43.6	29.9	59.9	28.60	53.77	41.0	12.8
18…………	20.3	69.5	34.9	52.3	10.1	60.2	18.85	60.67	34.0	10.0
19…………	0.1	68.1	30.8	72.8	11.6	53.2	13.53	64.70	33.0	—0.5
20…………	7.9	63.8	27.4	33.6	28.6	43.8	23.12	47.07	39.0	4.5
21…………	18.8	70.5	41.8	54.6	33.9	64.5	32.10	63.30	43.0	17.2
22…………	16.6	76.1	38.9	52.1	23.3	60.1	25.53	62.77	39.6	16.1
23…………	14.1	79.1	40.9	45.8	25.0	54.0	26.25	59.63	43.0	13.4
24…………	16.0	85.5	42.0	36.0	31.8	81.8	30.40	67.77	43.7	15.6
25…………	18.9	63.4	43.3	52.9	32.5	75.5	31.80	63.93	43.0	17.8
26…………	20.2	73.4	41.8	31.0	28.0	35.0	29.50	46.47	41.8	18.8
27…………	15.7	68.7	44.4	32.8	31.2	45.8	30.62	49.10	43.5	16.1
28…………	17.0	70.5	45.3	41.1	29.2	87.0	30.18	66.20	47.4	16.6
29…………	16.8	71.8	46.2	31.8	21.8	76.2	26.65	59.93	44.2	16.1
30…………	18.8	63.3	49.8	28.2	28.9	37.8	31.60	43.10	49.4	15.6
31…………	19.1	72.5	45.5	36.9	28.6	22.8	30.45	44.07	47.3	17.8
Sums. ……	……	……	……	……	……	……	……	……	……	……
Means …. ..	18.82	70.28	40.21	48.67	27.52	58.62	28.52	59.19	41.75	16.78

REMARKS.

Frosts frequent and heavy.

Solar halo on 8th; lunar halos on 8th and 12th.

Snow in neighboring mountains W, on the 12th, 14th and 20th.

Snow in mountains at close of month, none in the valley.

Month very dry.

RECORD FOR JANUARY.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Day of Month.	Range of temperature	Daily mean barometer ⅓ (7+2+9)	Precipitation in inches	Snow in inches	Wind.			Weather.			
					Direction from.			Cloud proportion scale 0-10.			State.
					7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	
1	13.6	25.674	.00	0.0	E	E	W	10	3	x	Fair.
2	21.3	25.590	.00	0.0	W	NE	E	1	4	x	Clear.
3	19.4	25.514	.00	0.0	NW	SW	W	8	4	3	Fair.
4	12.7	25.409	.00	0.0	SE	SW	SW	9	9	0	Fair.
5	23.6	25.530	.00	0.0	NW	E	NW	....	4	x	Clear.
6	25.9	25.569	.00	0.0	N	E	W	3	3	x	Clear.
7	25.6	25.512	.00	0.0	SW	E	N	0	2	x	Clear.
8	27.4	25.378	.00	0.0	W	SW	W	4	5	9	Fair.
9	26.3	25.325	.00	0.0	SW	SW	NE	2	3	0	Clear.
10	28.4	25.336	.00	0.0	SW	SW	W	4	7	9	Fair.
11	21.0	25.381	.00	0.0	W	NE	W	6	4	3	Fair.
12	25.6	25.185	r&s .02	.12	W	SW	W	3	3	x	Clear.
13	23.8	25.088	.00	0.0	N	E	N	1	3	8	Fair.
14	7.7	25.037	s T	T	NE	NE	N	9	7	4	Fair.
15	24.4	25.165	.00	0.0	NW	N	NW	2	x	x	Clear.
16	22.5	25.367	s† .20	2.0	NW	NE	NW	x	1	x	Clear.
17	28.2	25.270	s† .15	1.5	NE	W	W	9	3	4	Fair.
18	24.0	25.499	.00	0.0	NE	NE	NW	3	1	x	Clear.
19	33.5	25.646	.00	0.0	NW	E	W	0	1	x	Clear.
20	34.5	25.560	.00	0.0	E	NE	SW	4	5	6	Fair.
21	25.8	25.427	r T	0.0	SW	SW	N	9	6	x	Fair.
22	23.5	25.638	.00	0.0	W	NE	W	x	x	x	Clear.
23	29.6	25.739	.00	0.0	W	E	NW	1	1	0	Clear.
24	28.1	25.577	.00	0.0	W	E	NW	3	4	4	Fair.
25	25.2	25.653	.00	0.0	NE	NE	NE	2	x	0	Clear.
26	23.0	25.667	.00	0.0	NE	E	W	0	0	0	Clear.
27	27.4	25.671	.00	0.0	SW	E	E	0	0	0	Clear.
28	30.8	25.619	.00	0.0	W	E	NW	0	0	0	Clear.
29	28.1	25.549	.00	0.0	NW	E	N	0	x	0	Clear.
30	33.8	25.558	.00	0.0	NE	SE	NW	1	1	0	Clear.
31	29.5	25.700	.00	0.0	NE	SW	NW	1	3	0	Clear.
Sums	.....	......	0.37	·3.62	....	....	....	....	....	....	....
Means	24.97	25.478	......	......	W	E	W	3.1	2.8	1.6	Clear.

†=Estimated. x=Inappreciable. T=Trace.

RECORD FOR FEBRUARY.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

DAY OF MONTH.	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼(7+2+9+9.)….	Daily mean relative humidity ⅓ (7+2+9.)……	Maximum temperature….	Minimum temperature….
	7 A. M.		2 P. M.		9 P. M.					
	Temp…….	Hum…….	Temp…….	Hum…….	Temp…….	Hum…….				
1…………	19.0	58.4	48.7	27.9	30.4	56.4	32.12	47.57	50.2	15.8
2…………	20.9	34.6	52.8	28.2	33.0	51.0	34.93	37.93	52.6	16.1
3…………	23.1	61.1	53.1	41.7	33.2	47.4	35.65	50·07	54.6	21.0
4…………	21.8	73.2	55.8	30.6	36.1	56.1	37.45	53.30	58.7	20.6
5…………	24.2	49.2	55.9	33.9	35.4	61.0	37.72	48.03	59.4	22.9
6…………	26.5	29.8	56.0	17.6	37.8	49.6	39.53	32.33	57.9	25.7
7…………	25.0	42.4	52.7	35.7	31.0	57.0	34.93	45.03	52.3	24.4
8…………	23.9	55.9	49.1	34.4	30.9	50.9	33.70	47.07	49.5	20.9
9…………	21.0	60.4	54.9	26.1	35.9	57.9	36.92	48.13	53.8	18.9
10…………	23.5	44.7	53.9	23.5	40.1	34.7	39.40	34.30	56.7	20.6
11…………	25.8	43.2	57.5	22.1	42.8	43.4	42.23	36.23	58.1	24.9
12…………	26.5	40.1	60.2	23.8	43.8	39.6	43.57	34.50	62.1	25.9
13…………	31.5	60.0	57.2	20.2	32.8	43.8	38.58	41.33	58.9	27.3
14…………	21.8	65.4	24.6	73.2	20.8	64.4	22.00	67.67	32.6	21.2
15…………	16.9	71.9	24.3	75.3	8.6	68.6	14.60	71.93	27.1	9.4
16…………	8.0	59.0	23.1	76.5	11.0	63.5	13.27	66.35	30.3	3.9
17…………	4.1	52.7	32 4	68.4	25.9	78.4	22.08	66.50	33.9	2.6
18…………	13.9	66.9	35.9	54.1	26.5	40.1	25.70	53.70	37.0	12.6
19…………	18.0	71.5	43.3	31.3	32.8	73.8	31.72	58.87	45.9	15.5
20…………	23.9	52.3	53.9	40.1	39.0	49.4	38.95	47.27	54.3	20.3
21…………	26.8	37.6	56.9	30.3	40.0	62.2	40.93	43.36	59.6	26.3
22…………	40.5	49.3	56.9	18.0	47.8	17.6	48.25	28.30	60.3	33.4
23…………	30.2	48.2	45.5	41.3	37.8	44.8	37.83	44.77	47.5	27.1
24…………	32.9	63.5	43.7	56.3	37.9	76.5	38.10	65.43	49.2	31.1
25…………	32.9	90.0	53.8	33.8	39.8	68.6	41.57	64.13	52.9	31.5
26…………	29.1	36.2	58.3	25.3	38.5	52.9	41.10	38.13	58.3	26.4
27…………	27.1	33.4	62.3	22.3	47.6	41.8	46.15	32.50	63.9	24.1
28…………	29.8	78.8	57.0	30.4	43.9	42.2	43.65	50.47	57.7	27.0
Sums. ……	……	……	……	……	……	……	……	……	……	……
Means…….	23.88	54.63	49.27	37.23	34.33	53.34	35.45	48.40	51.27	21.34

REMARKS.

Frost was observed on the following dates: 1st to 13th, 16th to 21st, 26th to 28th, all dates inclusive.

Solar halo on 7th; lunar corona on 10th; lunar halo on 11th.

Atmosphere was hazy on 5th, 12th and 19th; much dust in air on 13th.

Very brilliant sunsets were observed on the 27th and 28th.

Snow in mountains S and W at the close of the month, but none in the valley.

RECORD FOR FEBRUARY.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Day of Month.	Range of temperature......	Daily mean barometer ⅓ (7+2+9.)......	Precipitation in inches.....	Snow in inches...........	Wind.			Weather.			
					Direction from.			Cloud proportion scale 0-10.			State.
					7 A.M......	2 P.M......	9 P.M......	2 A.M......	7 P.M......	9 P.M......	
1.............	34.4	25.811	.00	0.0	W	SE	W	0	x	0	Clear.
2.............	36.5	25.823	.00	0.0	W	E	W	2	x	0	Clear.
3.............	33.6	25.703	.00	0.0	NW	NE	N	x	x	0	Clear.
4.............	38.1	25.615	.00	0.0	NE	NE	W	0	0	0	Clear.
5.............	36.5	25.524	.00	0.0	NE	NE	W	1	2	1	Clear.
6.............	32.2	25.490	.00	0.0	NE	W	N	2	x	x	Clear.
7.............	27.9	25.568	.00	0.0	NE	E	NE	2	4	1	Clear.
8.............	28.6	25.600	.00	0.0	W	NW	NW	0	8	0	Clear.
9.............	34.9	25.704	.00	0.0	NE	E	N	x	x	0	Clear.
10.............	36.1	25.747	.00	0.0	NE	NE	W	0	x	x	Clear.
11.............	33.2	25.793	.00	0.0	SW	E	N	0	0	3	Clear.
12.....	36.2	25.663	.00	0.0	W	SE	NW	2	3	x	Clear.
13.............	31.6	25.225	.00	0.0	E	SW	N	x	3	8	Fair.
14.............	11.4	24.994	s† .05	.5	N	NE	NE	10	8	9	Cloudy.
15.............	17.7	25.114	s .23	2.6	NE	NE	W	10	8	7	Cloudy.
16.............	26.4	25.264	s T	T	E	NW	NW	7	6	x	Fair.
17.............	31.3	25.526	.00	0.0	NW	W	SW	x	5	9	Fair.
18.............	24.4	25.596	.00	0.0	SW	SW	E	0	x	2	Clear.
19.	30.4	25.626	.00	0.0	NW	SW	NW	4	6	3	Fair.
20.............	34.0	25.674	.00	0.0	NW	S	W	1	4	0	Clear.
21.............	33.3	25.624	.00	0.0	W	W	W	4	5	2	Fair.
22.............	26.9	25.407	.00	0.0	NW	SW	W	6	3	x	Fair.
23.............	20.4	25.326	r T	0.0	NW	W	W	5	8	4	Fair.
24.............	18.1	25.192	r T	0.0	SW	W	W	8	9	9	Cloudy.
25.............	21.4	25.409	r .01	0.0	NW	E	W	6	4	x	Fair.
26.............	31.9	25.667	.00	0.0	N	E	W	x	1	0	Clear.
27.............	39.8	25.652	.00	0.0	NW	SE	N	1	x	0	Clear.
28.............	30.7	25.674	.00	0.0	W	E	E	x	x	0	Clear.
Sums.....	......	......	0.29	3.10	....	....	....	....	....	....	....
Means.........	29.93	25.536	......	......	NW	E	W	2.5	2.9	2.1	Clear.

†=Estimated. x=Inappreciable. T=Trace.

RECORD FOR MARCH.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

DAY OF MONTH.	TEMPERATURE AND RELATIVE HUMIDITY.						Daily mean temperature ¼ (7+2+9+9)...	Daily mean relative humidity ⅓ (7+2+9)......	Maximum temperature....	Minimum temperature.....
	7 A. M.		2 P. M.		9 P. M.					
	Temp.......	Hum........	Temp.......	Hum........	Temp.......	Hum........				
1............	27.8	35.2	59.9	27.0	42.9	47.9	43.37	36.70	61.7	27.3
2............	29.8	68.2	61.0	21.2	44.5	49.5	44.95	46.30	61.0	28.3
3............	31.8	63.8	59.8	17.0	43.8	33.8	44.80	38.20	61.2	31.6
4............	30.4	56.4	58.8	29.0	44.5	45.3	44.55	43.56	59.4	26.8
5............	30.6	81.6	59.8	28.0	46.8	53.6	46.00	54.40	60.4	28.0
6............	33.0	72.0	61.2	26.0	51.1	42.1	49.10	45.70	63.4	28.8
7............	37.8	74.8	52.8	42.6	43.5	63.3	44.40	60.23	59.6	35.8
8............	33.5	92.0	53.0	62.6	40.8	45.6	42.03	66.73	54.0	32.2
9............	33.3	70.3	54.9	20.0	48.5	22.2	46.30	37.50	56.3	30.4
10............	32.8	72.8	55.9	30.1	46.9	42.9	45.62	48.60	56.9	29.7
11............	33.8	66.0	57.9	22.8	50.3	37.6	48.07	42.13	58.3	30.7
12............	44.8	74.0	56.0	42.4	46.9	66.0	48.65	60.80	59.1	44.6
13............	39.2	76.8	45.9	63.4	39.8	84.0	41.17	74.73	49.2	37.3
14............	39.9	72.7	45.7	45.9	40.1	68.0	41.45	62.20	47.5	34.8
15............	34.8	76.5	50.8	45.6	36.8	73.0	39.80	65.03	51.0	33.0
16............	28.8	89.0	46.0	46.2	40.8	52.8	39.10	62.66	46.8	27.9
17............	33.1	71.1	49.9	28.3	46.8	42.0	44.15	47.13	52.6	30.2
18............	46.0	53.4	47.3	35.5	33.9	64.5	40.27	51 13	50.4	33.4
19............	24.3	52.7	49.1	23.9	40.9	26.2	38.80	34.27	50.0	18.9
20............	34.0	81.8	47.5	39.3	39.9	51.1	40.33	57.40	49.9	32.4
21............	28.0	68.0	57.8	34.4	35.8	56.8	39.35	53.06	57.4	24.7
22............	30.8	25.6	64.8	27.2	47.0	45.4	47.40	32.73	65 1	26.1
23............	41.0	52.2	55.8	31.2	41.8	39.6	45.10	41.00	58.9	38.8
24............	33.9	62.9	51.5	23.0	39.9	32.1	41.30	39.33	52.8	28.5
25............	32.8	70.8	56.1	28.3	39.2	43.2	41.82	47.43	57.2	27.1
26............	31.9	53.8	62.3	15.9	53.6	37.4	50.35	35.70	63.9	27.6
27............	39.1	68.7	57.7	28.7	48.9	53.9	48.65	50.43	62.0	34.1
28............	40.5	85.6	63.6	26.8	51.9	45.9	51.97	52.77	64.5	36.5
29............	48.6	47.0	57.8	23.0	45.9	50.9	49.55	40.30	58.9	35.4
30............	37.9	65.9	60.9	23.1	48.0	34.4	48.70	41.13	62.7	31.3
31............	35.8	72.8	72.2	14.9	56.0	43.2	55.00	43.63	73.2	32.9
Sums.........	......	......	......	......	......	......	......	......	......	......
Means.......	34.83	66.92	55.93	31.39	44.44	48.20	44.91	48.84	57.59	31.13

REMARKS.

Frost was observed on the following dates: 1st to 6th, 8th to 11th, 15th, 16th, 19th, 21st, 22d, 24th to 26th, 30th and 31st.

Lunar corona on 6th; solar halos on 27th, 29th and 31st.

Snow, hail and rain on 14th, snow with rain on 18th.

Thin ice was observed on the 30th.

Snow in mountains W at close of month.

RECORD FOR MARCH.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Day of Month.	Range of temperature.	Daily mean barometer ⅓ (7+2+9).	Precipitation in inches.	Snow in inches.	Winds. Direction from. 7 A. M.	2 P. M.	9 P. M.	Weather. Cloud proportion scale 0-10. 7 A. M.	2 P. M.	9 P. M.	State.
1	34.4	25.565	.00	0.0	NW	E	W	0	x	1	Clear.
2	32.7	25.452	.00	0.0	SW	E	W	2	4	x	Clear.
3	29.6	25.466	.00	0.0	W	NE	W	3	2	x	Clear.
4	32.6	25.507	.00	0.0	N	E	NW	x	1	0	Clear.
5	32.4	25.491	.00	0.0	W	S	W	x	2	x	Clear.
6	34.6	25.451	.00	0.0	E	SW	W	0	3	2	Clear.
7	23.8	25.253	.00	0.0	NW	W	W	8	7	4	Fair.
8	21.8	25.206	r .02	0.0	W	S	NE	4	3	6	Fair.
9	25.9	25.336	.00	0.0	SW	E	W	3	4	5	Fair.
10	27.2	25.316	.00	0.0	NW	SE	NE	6	8	7	Fair.
11	27.6	25.360	.00	0.0	NW	SW	NW	1	4	10	Fair.
12	14.5	25.103	r T	0.0	SW	SW	S	8	9	9	Cloudy.
13	11.9	24.948	r .15	0.0	N	W	NE	10	8	10	Cloudy.
14	12.7	25.007	r s & h .36	T	SW	SW	W	9	8	6	Cloudy.
15	18.0	24.901	r .07	0.0	SW	SE	W	7	9	10	Cloudy.
16	18.9	25.025	.00	0.0	SW	E	NW	3	4	5	Fair.
17	22.4	25.291	.00	0.0	E	S	S	7	8	10	Cloudy.
18	17.0	25.430	r&s T	T	SW	SW	NW	4	9	5	Fair.
19	31.1	25.429	.00	0.0	W	S	S	1	8	7	Fair.
20	17.5	25.497	r & s † .05	0.5	W	W	NW	9	4	x	Fair.
21	32.7	25 759	.00	0.0	E	E	W	0	x	0	Clear.
22	39.0	25.670	.00	0.0	NW	E	W	0	4	3	Clear.
23	20.1	25.587	.00	0.0	W	W	NW	5	8	2	Fair.
24	24.3	25.583	.00	0.0	N	NW	NW	x	x	0	Clear.
25	30.1	25.523	.00	0.0	NW	SE	NW	x	1	x	Clear.
26	36.3	25.478	.00	0.0	E	E	W	x	5	1	Clear.
27	27.9	25.497	r T	0.0	W	SW	W	5	6	7	Fair.
28	28.0	25.527	.00	0.0	NW	SW	SW	8	5	4	Fair.
29	23.5	25.529	.00	0.0	W	W	W	4	5	x	Clear.
30	31.4	25.642	.00	0.0	NE	SW	W	2	1	0	Clear.
31	40.4	25.580	.00	0.0	NE	SW	W	3	2	x	Clear.
Sums	......	......	.65	0.5	....	....	....	....	....	....	....
Means	26.46	25.400	......	......	W	SW	W	3.6	4.4	3.7	Fair.

†=Estimated. x=Inappreciable. T=Trace.

SUMMARY, JANUARY, FEBRUARY and MARCH, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W. Altitude, 4552 feet.

		January 1889.	January 1888.	February 1889.	February 1888.	March 1889.	March 1888.
Air pressure. Readings corrected for temp.	Highest barometer, inches	25.767	......	25.814	......	25.779	.....
	Date	31	......	11	......	21	.....
	Lowest barometer, inches	25.024	......	24.928	......	24.831	......
	Date	14	......	15	......	15	......
	Range of barometer, inches	.743	......	.886	......	.948	.....
	Mean barometer, inches	25.478	......	25.536	......	25.400	......
Temperature, Farenheit.	Highest, degrees	52.9	63.4	63.9	75.9	65.1	87.5
	Date	9	23	27	28	22	13
	Lowest, degrees	—0.5	—12.7	2.6	14.0	18.9	13.2
	Date	19	14	17	29	19	1
	Monthly range, degrees	53.4	76.1	61.3	61.9	46.2	74.3
	Mean maximum, degrees	41.75	40.27	51.27	61.04	57.59	61.13
	Mean minimum, degrees	16.78	14.58	21·34	24.88	31.13	25.70
	Greatest daily range, degs	34.5	35.0	39.8	50.2	39.0	59.0
	Date	20	9	27	28	22	13
	Least daily range, degrees	7.7	14.5	11.4	13.9	11.9	15.0
	Date	14	20	14	10	13	4
	Mean daily range, degrees	24.97	25.69	29.93	36.16	26.46	35.43
	Mean ½ (m. max + m. min.)	29.27	27.18	36.31	42.96	44.36	43.42
	Mean ¼(7×2×9×9) degrees	28.52	......	35.45	......	44.91	......
Mean relative humidity, per cent		59.19	......	48.40	......	48.84	......
Mean dew point, degrees		15.13	......	16.22	......	24.45	......
Total precipitation, inches		0.37	1.72	0.29	Trace.	0.65	*.57
Total snow-fall, inches		3.62	3.7	3.1	0.0	0.5	*7.0
Frost, number times observed		*	......	22	......	20	......
Thunderstorms, number of		0	......	0	......	0	......
Weather.	Rainy days	3	8	3	0	5	8
	Cloudy days	0	17	3	3	5	9
	Fair days	12	6	8	9	11	10
	Clear days	19	8	17	17	15	12
	Prevailing	Clear.	Cloudy.	Clear.	Clear.	Clear.	Clear.
Wind. Times observed blowing from	North	8	......	8	......	3	......
	Northeast	17	......	15	......	6	......
	East	16	......	11	......	12	......
	Southeast	2	......	3	......	3	......
	South	0	......	1	......	7	......
	Southwest	14	......	8	......	17	......
	West	21	......	24	......	29	......
	Northwest	15	......	14	......	16	......
	Prevailing	West.	......	West.	......	West.	......
Times of calm		0	......	0	......	0	......

* Not recorded satisfactorily.

Nevada Agricultural

EXPERIMENT STATION,

Bulletin No. 5,

JUNE, 1889.

METEOROLOGICAL REPORT

FOR

April, May and June, 1889,

BY

W. S. DEVOL, B. Ag.

RENO:
STATE JOURNAL OFFICE PRINT.
1889.

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METEOROLOGICAL REPORT

FOR

April, ✱ May ✱ and ✱ June, ✱ 1889

The location of the Experiment Station, the instruments used in making the meteorological observations, and the methods employed, were fully discussed in Bulletins 3 and 4.

The observations for April 1st to April 13th, inclusive, used in making some comparisons in this Bulletin, were made by Mr. C. M. Fassett, at that time acting observer for the State Weather Service. All observations since that date were made at this Station.

For facts concerning other places in the State than at the Experiment Station, I am indebted to the State Weather Service, C. W. Friend, Director; and to the U. S. Signal Service, A. W. Greeley, Chief Signal Officer.

In all statistics in this Bulletin the barometer readings have been corrected for temperature, but not altitude; nor has altitude been taken into consideration in determining dew point and relative humidity.

Daily weather predictions were received from the U. S. Signal Service at San Francisco, and the proper signals floated from the flagstaff of the University tower. These predictions were concerning the state of the weather—whether it was to be clear, fair, cloudy or rainy; and the temperature—whether it was to be cooler or warmer, or the temperature to remain about stationary. Of the predictions as to weather, 92.3 per cent. were verified by the state of the weather for the twenty-four hours following the hour of the prediction, or less than 8 per cent. of the predictions were eronious. This high percentage of verification is due in part to the uniformity of the character of the weather from day to day, the greater portion of the days being clear or fair. The predictions as to temperature were not so fortunate, the verification being but 51.3 per cent., or about half. But in these the readings of the instruments were made to verify only when within four degrees of prediction. Thus, if the prediction was for "nearly stationary temperature," and the mean temperature was four or more degrees higher or lower, the prediction was said not to have been verified.

PRINCIPAL FEATURES OF THE WEATHER FOR THE QUARTER.

ATMOSPHERIC PRESSURE.

The mean atmospheric pressure for April was 25.432 inches. The highest barometer was 25.684 inches on the 21st; the lowest was 25.144 inches on the 13th, giving a range of .544 inch. The barometer was lower during May than in April. The mean atmospheric pressure was 25.404 inches, or .028 inch below that of April. The highest barometer was 25.663 inches, on the 18th, or .021 inch below highest April reading. The minimum pressure occurred on the 5th, and was 25.034 inches, .11 inch lower than lowest for April, and giving a range for the month of .629 inch. The mean atmospheric pressure for June was 25.434 inches. The highest barometer in June was 25.581 inches, on the 9th; the lowest, 25.245 inches, occurred on the 27th; the monthly range was .336 inch, and the monthly mean was 25.434 inches, being .002 inch higher than the mean for April and .03 above that for May. The highest and lowest readings were both below the corresponding readings for April and May.

The mean atmospheric pressure for the quarter was 25.422 inches. The highest was 25.684 inches on the 21st of April, and the lowest was 25.034 inches on the 5th of May. The range of atmospheric pressure was .65 inch, and the greatest daily range was .232 inch on the 8th of May.

TEMPERATURE OF THE AIR.

April.—The mean temperature for April was 52.01°; as compared with April of last year (54.20°), it was a cooler month by 2.19°. The warmest day was the 25th, when the mean temperature was 64.42°. The lowest daily mean temperature was 35.1°, on the 13th. The mean of April, 1889, for the State, taken from twenty-five observing stations, was 53.5°. The highest monthly mean at any observing station in the State was 76.8° at El Dorado Canyon, Lincoln County, near the southern point of the State. The lowest mean temperature was 42.2°, at Ruby

Hill, White Pine County. A range of 32.6° is found between the mean temperatures of the two points named. The highest temperature at the Experiment Station given by the readings of the maximum thermometer, was 79.8° on the 26th. The lowest reading of the maximum thermometer was 48.9° on the 14th, making a range of 30.9° between the highest reading on the two dates given. The lowest temperature, as indicated by minimum thermometer, was 25.4° on the 18th, making a range of 54.4° between the highest and the lowest temperatures at the Experiment Station. On the 18th the minimum thermometer remained the highest; the lowest register on that date being 46.9°. The greatest daily range of temperature was on the 19th, when there was a difference of 40.6° between the highest and lowest temperatures.

The highest maximum temperature for the State was 92° on the 30th at Palisade, Eureka County. The lowest minimum for the State was 15° on the 18th, at Eureka, Eureka County, making the large range of 76.5°, and at points not far apart in same county.

MAY.—Mean temperature for May at the Experiment Station was 4.66° higher than for June, being 56.67°, which was but .05° higher than the mean for May, 1888. The warmest day of the month was the 28th when the mean temperature was 73.1°. This was nearly three degrees higher than the warmest day for the same month last year. The coolest day was the 5th, when the daily mean temperature was 36.6°, making the range of daily mean temperatures 36.5°. The mean temperature for May for the whole State was 57.8°, ranging from 49.4°, at Ruby Hill, to 83.1°, at El Dorado Canyon, the same localities as in April.

The highest maximum temperature at the Experiment Station was 89.7° on the 26th, and was nearly 10° higher than the highest for April. The highest for May, 1888, was 87.30°, which was 2.4° degrees below the maximum for May of this year. The lowest temperature given by maximum thermometer for May, was 43.6° on the 6th. The lowest minimum temperature was 29.4° on the 10th, 4° above the lowest for April. The range between highest and lowest temperatures was 60.3°. The greatest range of temperature on any one day was 39° on the 23d, and the least was 10.3 on the 6th.

The highest maximum temperature for the State was 106° on the 28th and 29th, at El Dorado Canyon. The lowest minimum was 20° at Ruby Hill on the 16th, and at Wellington on the 8th. This makes a range of 86° for the month, which is 9.5° greater than that for April.

JUNE.—The monthly mean temperature for June was 69.79°, which was 13.12° higher than the mean for May, and 17.78° higher than that for April; but the mean for June of last year, 1888, was 9.79° lower than for this year. The 3d was the warmest day of the month, the daily mean temperature of which was 76.6°. The fore part of the month was warmer than the latter part, the mean temperature for the first six days having been more than three degrees above that for the last six days. The coolest day, also, was near the end of the month—the 27th—and the daily mean temperature was 55.85°. The coolest day in June of last year was 50.1°, or 5.75° less than that of '89, and was also late in the month—17th.

The highest maximum temperature for June, 1899, was 91.3° on the 12th, which is the highest thus far recorded this year, and is 5.3° higher than the maximum for June, 1888. On the 27th, the date of the lowest daily mean temperature, the lowest maximum temperature was recorded, the highest temperature on that day being 67.2°. The lowest and highest readings of the minimum thermometer were 37.5° on the 28th, and 56.6° on the 4th, respectively. The monthly range of temperature was 53.8°; the greatest daily range was 41.3° on the 11th, and the least daily range 19.6° on the 27th, the coldest day. The range of temperature for the quarter was 65.9°; the mean temperature for the quarter was 59.28°.

DEW POINT AND RELATIVE HUMIDITY.

The mean relative humidity—*i. e.*, the per cent. of saturation of the atmosphere at the mean temperature—for April was 42.96 per cent.; for May 43.25 per cent.; for June 32.78 per cent. The lowest humidity in April was 9.1 per cent. at 2 P. M. on the 22d, the lowest in May 6.5 per cent. at 2 P. M. on the 27th. In June it was 1 per cent. at 2 P. M. on the 25th. The lowest daily mean relative humidity in April was 32.5 per cent. on the 19th; in May 22.5 per cent. on the 31st; in June 22.76 per cent. on the 25th. The highest observed relative humidity in June was 76.4 per cent. at 7 A. M., on the 10th; in May 93 per cent. at 7 A. M., on the 5th; in June 69.4 per cent. at 7 A. M., on the 28th.

The dew point—*i. e.*, the temperature at which dew would form with the observed atmospheric moisture—in April, which was nearest the air temperature, was 38.8°, when the air temperature was 46.8° at 7 A. M., on the 12th. In May the dew point was nearest the actual or air temperature at 7 A. M., on the 9th, the difference being 8 degrees. In June the dew point and actual temperature were most nearly the same on the 6th, at 7 A. M., the former being 47.2°, and the latter 11.6° higher. The lowest dew point was at 2 P. M., June 25th, when it was 25° below zero.

PRECIPITATION.

The principle conditions not always available under which a crop can be grown are a warm temperature and sufficient moisture. The former can vary more, and still be able to cause most farm crops to mature, than can the latter. Without a sufficient amount of water no crop can be grown, but with water the soil and temperature are *usually* such as to bring forth a crop of some kind. Water, then, is the all-important thing. This is especially true of Nevada, for our most barren soils are found abundantly fertile, in most instances, when sufficient water is applied. The rainfall throughout the greater part of Nevada is very small. The absence of vegetation upon such large tracts of our State is due chiefly to this lack of water. This is verified over and over again, in that wherever irrigation has been resorted to, vegetation springs up, and with sufficient water supplied in this way, fairly good to excellent crops of various kinds can be grown upon almost all the kinds of soil within our borders.

Except from February to October, 1883, a continuous record of the rainfall at Reno was kept from July, 1881, to November, 1887, by the Central Pacific Railroad. The average annual precipitation for the period of six years and three months, during which the observations were made, was 4.58 inches. The maximum yearly rainfall was 6.17 inches in 1884, and the minimum was 2.95 inches in 1885. That for 1888, as observed at the Experiment Station, was 7.4 inches, or nearly 3 inches above the average found by the Railroad, and 1.23 inches above the maximum annual of their observations.

The rainfall for April, May and June of 1889, observed at the Experiment Station, as compared with the average, maximum, and minimum obtained by the observer of the Central Pacific Railroad, may be conveniently tabulated, as follows:

MONTH.	Experiment Station. 1889.	Central Pacific Railroad.				
		Average.	Maximum.		Minimum.	
	In.	In.	In.	Yr.	In.	Yr.
April	0.03	0.28	0.80	1885	0.00	'83, '86
May	1.825	0.25	0.60	1882	0.00	'84, '85
June	Trace.	0.18	0.80	1884	0.00	Frequently.

The precipitation for April is thus shown to vary from nothing, as in 1883 and 1886, to .8 inch, as in 1885. For May the range is from nothing, as in 1884 and 1885, to 1.825 inches, as in 1889, the latter being the wettest May of which we have any record. In June there is frequently an entire absence of rain in appreciable quantity, and the maximum precipitation is .8 inch.

The total rainfall for the quarter in 1889 was 1.855 inches.

WIND.

The air at the Experiment Station is moving almost constantly, there having been but two observations for the quarter at which no movement of the air was observable. The greatest number of times it was observed blowing from one direction was 82, from the west. The next greatest was 58, from the east; and the next, 42 from the southwest; and the next, 25 from the northwest. The prevailing winds are from the west. At 7 A. M. the prevailing winds are from the east; at 2 P. M. from the south-west, and at 9 P. M. from the west.

The maximum velocity of the wind for April was 8 (scale of 0–10) from the west at 2 P. M., the 14th. This was also the maximum for the quarter. The maximum for May was 7 from the southwest at 2 P. M. the 2d, and from the west at 2 P. M. the 7th. The June maximum was 6, from the west at 2 P. M. the 21st.

FROSTS.

Frosts occurred in April on the mornings of the 6th, 7th, 10th, 16th, 17th, 18th, 19th, 20th and 29th. In May there were frosts on the 3d, 10th, 11th and 18th. There were no frosts in June. This is unusual, as one or more frosts commonly are had in June.

MISCELLANEOUS.

There was quite a snow storm on the evening of the 7th and the morning of the 8th of May. Between the hours of 9 and 10 P. M. of the 7th 2½ inches of heavy snow fell. The storm was quite general throughout the northern portion of the State.

The rain on the 4th, 5th and 6th of May wet the soil to quite a depth. On the morning of the 7th an examination was made of the different kinds of soil at the Station to determine the depth to which it was moistened. In a heavy clay soil, badly sun-cracked, the water penetrated to a depth of 9 inches. In a stiff clay loam, alfalfa sod, it wet through 4½ inches, and 1½ inches stiff clay underneath it. At another point in the alfalfa it wet through 4 inches of clay loam and 1 inch clay underlying it. At another point it moistened 4 inches of bare clay loam and 2 inches clay beneath. At another place in the field it wet through 9 inches of clay loam, and near this, through 8½ inches of clay loam and 1 inch clay underlying it.

It was cloudy in the east at sunrise 14 mornings in April, 11 in May and 8 in June. It was cloudy in the west at sunset 17 times in April, 15 times in May and 9 times in June. Clear sunrise, 10 times in April, 4 times in May, 9 times in June.

The records of the observations are on the following pages.

W. S. DEVOL,
Superintendent of Field Experiments.

METEOROLOGICAL RECORD FOR APRIL, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

DAY OF MONTH.	TEMPERATURE* AND RELATIVE HUMIDYIT.†						Daily mean temperature ¼ (7+2+9+9.)*...	Daily mean relative humidity ⅓ (7+2+9.)†......	Maximum temperature*...	Minimum temperature*....
	7 A. M.		2 P. M.		9 P. M.					
	Dry Bulb....	Relative Humidity...	Dry Bulb....	Relative Humidity ..	Dry Bulb....	Relative Humidity...				
1...........	44.9	63.9	70.5	20.4	56.9	37.3	57.30	40.40	72.8	37.2
2...........	44.9	70.3	72.3	15.0	59.9	38.9	59.25	40.80	73.8	39.8
3...........	50.2	55.2	70.9	18.7	55.8	24.4	58.20	32.80	75 1	42.7
4...........	46.5	74.1	61.3	24.6	48.8	50.2	51.32	49.62	68.0	39.9
5...........	45.7	60.7	49.5	44.0	40.9	62.9	45.75	55.97	51.0	42.5
6...........	36.3	44.1	60.1	23.1	48.5	45.1	48.35	37.43	62.8	29.9
7...........	38.5	68.1	......	......	55.3	49.3	......	......	70.3	33.5
8...........	50.6	52.6	51.7	70.9	52.9	45.1	52.00	56.20	57.0	46.9
9...........	46.8	73.4	70.3	22.0	56.1	43.3	57.30	46.20	69.8	39.9
10...........	44.5	76.4	56.5	37.7	47.8	60.4	49.90	58.20	65.7	38.3
11...........	44.5	68.1	62.3	35.5	51.0	55.4	52.20	53 00	62.9	43.5
12...........	48.3	36.0	58.5	29.6	45.9	59.1	49.85	41.60	61.7	40 6
13...........	47.3	43.2	47.7	30.5	37.0	55.2	35.10	45 00	52.2	36.1
14...........	37.0	46.0	46.6	22.4	38.8	51.4	40.50	39 90	48.9	33.6
15...........	38.1	42.9	49.4	38.8	41.5	51.1	42.60	44.30	52.2	33.4
16...........	37.6	58.6	55.5	26.5	44.8	47.4	45.68	44.17	57.2	30.2
17...........	41.3	65.1	51.2	31.6	38.0	35.6	42.12	44.10	56.0	32.9
18...........	35.7	66.3	51.0	33.0	41.3	36.2	42.32	45 17	56.2	25 4
19...........	36.8	52.8	66.7	11.9	54.8	32.8	53.27	32.50	68.8	28.2
20...........	45.1	66.5	64.5	24.5	48.1	39.9	51.45	43.63	66.7	36.1
21...........	40.5	68.0	68.5	22.6	55.8	29.6	55.15	40.07	71.0	38.5
22...........	46.6	60.4	71.0	9.1	54.8	38.2	56.80	35.90	74.0	38.4
23...........	49.4	47.8	70.0	21.8	57.2	43.4	58.45	37.68	72.4	40.1
24...........	48.7	54.9	71.5	22.6	59.6	39.4	59.60	38.80	76.6	44.1
25...........	53.1	50.9	77.0	13.8	63.8	34.2	64.42	32.97	77 6	41.4
26...........	50.0	60.4	78.5	4.5	58.9	32.9	61.58	32.60	79.8	41.3
27...........	59.8	53.6	59.9	58.2	43.5	50.9	51.45	54.23	62.1	42.8
28...........	44.6	44.8	......	......	50.8	42.8	......	......	58.1	40.6
29...........	46.0	67.6	69.0	24.8	49.0	47.4	53.25	46.60	69.8	38.4
30...........	48.5	52.3	72.5	15.5	61.9	31.5	61.20	33.27	74.8	38.1
Sums.	134.78	1745.0	1754.4	753.3	1519.4	1311.3	1456.36	1203.11	1964.3	1134.2
Means.......	44.9	58.1	62.6	26.9	41.4	43.7	52.01	42.96	65.4	37.8

* In degrees Fahrenheit. † Per cent. § Inches. — Less than 1.

REMARKS.

Frosts were observed on the 6th, 7th, 10th, 16th, 17th, 18th, 19th, 20th and 29th.

Lunar halo on the 6th.

Sleet and rain from clear sky at 1 to 3 o'clock P. M. on the 13th.

Atmosphere hazy at sunrise on the 9th; at sunset on the 11th, 21st, 26th, 29th and 30th.

Red sunrise on the 4th, 7th, 19th, 20th and 21st.

Red sunset on the 3d, 17th, 18th and 28th.

Smoky about the foothills the 30th.

METEOROLOGICAL RECORD FOR APRIL, 1889.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Range of temperature*...	Daily mean barometer§..	PRECIPITATION.		WIND.			WEATHER.			
		Total amount of rain and melted snow, in inches and hundredths.........	Average depth of snow, in inches...	Direction from.			Cloud proportion. (Scale 0-10.)			Average State.
				7 A. M.....	2 P. M.....	9 P. M.....	7 A. M.....	2 P. M.....	9 P. M.....	24 hours...
35.6	25.481	0.00	0.00	SW	SW	W	3	3	—	Clear.
33.0	25.411	0.00	0.00	W	E	E	4	3	4	Fair.
32.4	25.445	0.00	0.00	E	E	W	—	5	6	Fair.
28.1	25.352	0.00	0.00	E	SW	W	2	10	—	Fair.
8.5	25.426	T	0.00	SW	SW	NW	8	10	4	Fair.
32.9	25.493	0.00	0.00	E	NE	W	—	1	4	Clear.
36.8	....	0.00	0.00	SW	.....	W	1	.....	7	Fair.
10.1	25.202	.03 R	0.00	N	W	N	8	10	9	Rainy.
29.9	25.257	T R	0.00	N	SE	W	8	6	8	Fair.
17.4	25.201	T R	0.00	E	W	NW	—	7	9	Fair.
18.4	25.297	T R	0.00	NW	SE	W	9	8	—	Fair.
21.1	25.314	0.00	0.00	W	W	W	6	10	6	Cloudy.
16.1	25.185	T	T	SW	W	W	6	5	8	Fair.
15.8	25.266	0.00	0.00	W	W	W	5	1	3	Clear.
18.8	25.470	T	T	W	W	W	8	8	4	Fair.
27.0	25.578	0.00	0.00	W	W	W	4	8	2	Clear.
23.1	25.548	0.00	0.00	NE	NE	N	6	7	—	Fair.
30.8	25.436	0.00	0.00	NE	E	N	—	—	0	Clear.
40.6	25.394	0.00	0.00	E	SE	W	0	0	0	Clear.
30.6	25.516	0.00	0.00	E	W	W	5	6	1	Fair.
32.5	25.645	0.00	0.00	W	W	NW	8	2	2	Fair.
35.6	25.617	0.00	0.00	SW	NW	N	4	5	4	Fair.
32.3	25.591	0.00	0.00	E	E	N	5	8	2	Fair.
32.5	25.533	0.00	0.00	E	E	E	9	9	—	Fair.
36.2	25.584	0.00	0.00	E	S	E	—	.....	1	Clear.
38.5	25.505	0.00	0.00	E	W	E	1	0	2	Clear.
19.3	25.391	T R	0.00	NE	W	W	1	1	2	Clear.
17.5	....	0.00	0.00	W	.....	W	8	—	2	Fair.
31.4	25.485	0.00	0.00	W	SE	W	.....	2	0	Clear.
36.7	25.492	0.00	0.00	E	E	W	0	—	—	Clear.
830.1	712.115	0.03	Trace.	.....	.....	.....	109	125	85	....
27.6	25.432	0.001	....	E	W	W	3.6	4.2	2.8	Fair.

METEOROLOGICAL RECORD FOR MAY, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

DAY OF MONTH.	TEMPERATURE* AND RELATIVE HUMIDITY.†						Daily mean temperature ¼ (7+2+9+9.)*..	Daily mean relative humidity ⅓ (7+2+9.)†....	Maximum Temperature*...	Minimum temperature* ...
	7 A. M.		2 P. M.		9 P. M.					
	Dry Bulb....	Relative Humidity..	Dry Bulb....	Relative Humidity..	Dry Bulb....	Relative Humidity..				
1...........	50.6	69.0	74.0	15.8	61.0	31.8	61.65	38.87	76.0	44.7
2...........	53.9	22.1	50.2	50.4	44.9	39.9	48.47	37.47	61.9	44.7
3...........	41.9	57.1	61.3	18.6	49.8	30.0	50.70	35.23	63.4	32.1
4...........	45.3	43.5	50.5	35.5	45.8	44.8	46.85	41.27	52.0	40.6
5...........	37.2	93.0	36.6	95.0	36.3	73.3	36.60	87.10	46.0	32.2
6...........	37.0	55.2	40.5	78.4	36.8	67.0	37.75	66.87	43.6	33.3
7...........	35.9	68.1	46.5	37.2	33.5	89.0	37.35	64.77	47.9	30.5
8...........	33.9	80.1	45.7	51.9	43.3	57.7	41.55	63.23	50.2	29.4
9...........	46.3	62.0	58.0	32.0	48.2	63.8	50.18	54.73	60.2	37.9
10...........	44.5	73.7	65.0	21.2	50.9	57.1	52.82	50.67	67.8	35.1
11...........	47.9	72.3	68.5	26.3	56.8	56.2	57.50	51.60	70.9	39.1
12...........	55.0	42.4	63.7	18.9	51.0	51.2	55.17	37.50	65.4	48.7
13...........	53.8	36.8	54.7	39.7	47.5	57.1	50.87	44.53	56.2	45.1
14...........	49.8	54.8	49.5	56.9	37.8	75.6	43.72	62.43	57.1	37.4
15...........	36.5	79.6	46.7	43.9	38.7	58.7	40.15	60.77	48.5	31.7
16...........	40.9	46.5	54.5	31.3	47.9	49.9	47.80	42.57	56.3	35.8
17...........	47.7	65.2	60.0	38.2	51.5	56.5	52.67	53.30	62.8	42.3
18...........	48.2	74.8	71.9	31.0	56.1	41.5	58.07	50.77	72.3	38.6
19...........	50.3	72.4	76.2	21.3	65.4	34.2	64.32	42.63	78.1	40.0
20...........	54.9	68.2	79.2	16.6	65.1	24.1	66.07	36.50	80.5	46.0
21...........	61.0	45.8	75.9	14.1	55.2	40.8	61.82	33.57	70.0	45.5
22...........	54.0	58.4	75.8	14.4	59.9	38.9	62.05	38.90	78.0	41.5
23...........	55.2	30.4	77.4	16.6	67.5	29.7	66.90	25.57	78.7	45.0
24...........	57.2	39.2	80.9	13.6	65.4	25.8	67.22	26.20	82.8	47.0
25...........	57.4	60.6	86.1	13.2	73.0	29.6	72.37	31.13	86.3	47.3
26...........	62.3	52.7	87.2	11.4	71.3	20.6	73.02	28.23	89.7	51.6
27...........	61.1	49.5	84.9	6.5	63.7	32.9	68.35	29.63	86.2	50.0
28...........	61.6	55.8	84.8	18.2	73.0	4.6	73.10	26.20	86.1	49.6
29...........	63.4	46.4	86.7	6.3	68.6	25.6	71.82	26.10	88.1	52.9
30...........	60.6	45.4	83.7	21.9	71.0	23.0	71.57	30.10	85.0	50.5
31...........	60.6	55.6	83.9	14.2	64.9	27.7	86.57	22.50	85.1	50.0
Sums.	1565.9	1766.6	2070.5	915.5	1701.8	1358.6	1757.05	1340.94	2133.1	1296.1
Means	50.5	56.9	66.7	29.5	54.9	43.8	56.67	43.25	68.8	41.8

* In degrees Fahrenheit. † Per cent. § Inches. — Less than 1.

REMARKS.

Frost occurred on the 3rd, 10th, 11th and 18th.
Solar halo at 3:15 P. M. on the 12th.
Snow on the 5th, 6th, 7th and 18th.
Ice on the 6th and 7th.
Dew on the morning of the 20th.

METEOROLOGICAL RECORD FOR MAY, 1889.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Range of temperature....	Daily mean barometer....	PRECIPITATION.		WIND.			WEATHER.			
		Total amount of rain and melted snow in inches and hundredths......	Average depth of snow in inches...	Direction from.			Cloud proportion. (Scale 0-10.)			Average State.
				7 A. M.....	2 P. M.....	9 P. M.....	7 A. M.....	2 P. M.....	9 P. M.....	24 hours...
31.3	25.355	0.00	0.00	E	W	W	3	5	1	Clear.
17.2	25.280	T	0.00	W	SW	W	3	5	1	Clear.
31.3	25.322	0.00	0.00	E	E	NW	—	5	4	Clear.
11.4	25.210	0.18	0.00	SW	SW	S	5	9	6	Fair.
13.8	25.109	1.24	0.00	S	SW	W	10	9	8	Rain.
10.3	25.145	0.09	0.00	W	SW	W	5	10	2	Fair.
17.4	25.198	T	0.50	SW	W	W	5	3	10	Fair.
20.8	25.412	0.16	1.75	NE	N	NE	8	7	2	Fair.
22.3	25.560	0.00	0.00	N	NE	E	2	4	0	Clear.
32.7	25.499	0.00	0,00	E	SW	W	0	—	0	Clear.
31.8	25.343	0.00	0.00	E	W	NW	0	2	5	Clear.
16.7	25.347	0.00	0.00	NW	SW	NW	3	8	4	Fair.
11.1	25.331	T	0.00	SW	W	W	5	9	6	Fair.
19.7	25.278	0.072	0.00	NE	SW	W	8	6	5	Fair.
16.8	25.333	0.083	T	W	W	W	7	6	4	Fair.
20.5	25.478	0.00	0.00	NW	NW	NW	6	9	—	Fair.
20.5	25.539	0.00	0.00	E	SW	W	4	9	1	Fair.
33.7	25.624	0.00	0.00	E	SE	W	3	3	—	Clear.
38.1	25.569	0.00	0.00	E	N	NW	2	9	2	Fair.
34.5	25.458	0.00	0.00	NE	SW	W	1	½	—	Clear.
24.5	25.428	0.00	0.00	E	W	W	—	—	0	Clear.
36.5	25.393	0.00	0.00	E	NW	W	1	—	1	Clear.
33.7	25.477	0.00	0.00	Calm.	E	NW	1	1	0	Clear.
35.8	25.577	0.00	0.00	SE	SW	SW	1	1	—	Clear.
39.0	25.568	0.00	0.00	E	E	W	—	—	0	Clear.
38.1	25.462	0.00	0.00	SW	Calm.	W	0	3	1	Clear.
36.2	25.468	0.00	0.00	E	SW	NW	2	9	—	Fair.
36.5	25.428	0.00	0.00	E	W	W	3	4	0	Clear.
35.2	25.429	0.00	0.00	E	W	NW	—	—	1	Clear.
34.5	25.411	0.00	0.00	E	SE	N	2	7	1	Clear.
35.1	25.405	0.00	0.00	NE	S	N	2	—	—	Clear.
837.0	787.436	1.825	....	.....	.....	.....	92.0	138.5	65.0	....
27.0	25.404	.059	....	E	W	W	3.0	4.5	2.1	Clear.

REMARKS.

Hazy atmosphere at sunrise on the 1st, 18th, 20th, 21st, 24th, 25th, 26th, 27th, 28th 29th, 30th and 31st.

Hazy atmosphere at sunset on the 16th, 18th, 22d, 23rd, 24th and 28th.

Smoky about foot-hills the 19th.

Two false suns near sunset of the 30th and 31st.

METEOROLOGICAL RECORD FOR JUNE, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION.

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

DAY OF MONTH.	TEMPERATURE* AND RELATIVE HUMIDITY.†						Daily mean temperature ¼(7+2+9+9.)*...	Daily mean relative humidity ⅓ (7+2+9.)†......	Maximum temperature*....	Minimum temperature*....
	7 A. M.		2 P. M.		9 P. M.					
	Dry Bulb	Relative Humidity...	Dry Bulb....	Relative Humidity ..	Dry Bulb....	Relative Humidity ..				
1	61.7	51.3	83 4	14.6	69.1	17.3	70.82	27.73	85.3	50.1
2	60.8	50.0	86.8	11.3	69.0	33.4	71.40	31.53	87.5	49.1
3	63.8	56.6	88.4	12.0	77.1	28.0	76.60	32.20	90.0	52.7
4	67.3	55.6	79.3	33.4	73.0	33.2	73.15	40.73	87.2	58.6
5	66.1	64.2	79.9	18.1	64.2	45.2	68.60	42.50	82.0	55.4
6	58.8	65.8	68.7	49.5	67.0	26.8	60.37	47.37	82.2	48.9
7	61.8	45.8	77.6	35.2	68.3	40.7	69.00	40.57	79.4	51.5
8	61.2	61.4	80.2	20.2	67.2	17.6	68.95	23.17	82.0	53.4
9	62.8	43.8	79.9	12.4	61.8	18.0	66.57	24.73	81.0	50.7
10	57.1	34.1	86.9	......	64.9	13.1	......	......	85.8	44.8
11	60.8	48.4	86.9	4.1	74.5	23.7	74.17	25.40	89.3	48.0
12	65.0	51.6	89.8	10.2	73.0	26.6	75.20	29.46	91.3	56.0
13	65.3	52.3	74.0	42.6	66.0	32.8	67.82	45.90	87.0	54.8
14	62.9	61.9	81.5	4.5	67.9	24.5	70.05	30.30	82.3	51.6
15	63.7	44.1	76.7	10.0	60.0	19.0	65.10	24.36	78.8	51.4
16	53.4	67.6	......	......	67.9	39.5	......	......	80.2	45.7
17	62.5	49.3	81.5	18.0	70.8	26.8	71.40	31.36	87.7	52.7
18	63.9	46.9	84.3	18.7	71.1	26.3	72.60	30.63	85.3	55.3
19	66.9	37.7	80.9	13.9	69.0	11.0	71.45	20.86	92.5	55.8
20	63.7	44.3	83.4	7.6	73.0	25.4	73.27	25.76	89.0	48.6
21	69.1	43.9	78.8	12.9	64.2	36.2	69.07	31.00	86.9	56.7
22	62.5	54.1	82.7	12.4	69.0	23.7	70.80	30.06	84.0	49.7
23	60.0	44.0	84.3	12.9	71.1	15.0	71.62	23.96	87.6	48.0
24	63.7	41.5	87.8	50.0	......	......	......	......	89.1	47.7
25	64.6	50.4	88.0	1.0	70.0	16.9	73.15	22.76	89.2	49.3
26	58.7	24.3	77.0	21.5	64.8	36.0	66.32	27.27	78.0	52.2
27	63.8	35.8	54.0	57.8	52.8	58.4	55.85	50.67	67.2	47.6
28	57.0	69.4	74.4	26.4	63.8	44.8	63.25	46.86	75.0	37.5
29	60.8	64.6	87.1	9.9	68.9	26.7	71.42	33.73	87.3	48.6
30	61.2	44.2	83.9	8.5	70.4	62.1	71.45	30.70	87.0	47.3
Sums.	1870.9	1504.9	2348.1	548.7	1869.8	847.7	1882.45	881.67	2537.1	1521.0
Means	62.36	50.16	80.96	19.59	64.47	29.23	69.79	32.78	84.57	50.70

* In degrees Fahrenheit. † Per cent. § Inches. — Less than 1.

REMARKS.

No frosts occurred in June.
Hail the 13th.
Thunder storms on the 4th, 13th, 21st and 27th.
Solar halo the 14th and 20th.
Lunar halo the 2d, 3d and 4th.
Smoky the 11th, 16th, 18th, 19th and 24th.
Sun dogs on 1st and 2d.

METEOROLOGICAL RECORD FOR JUNE, 1889.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Range of temperature*....	Daily mean barometer†....	PRECIPITATION.		WIND.			WEATHER.			
		Total amount of rain and melted snow, in inches and hundredths........	Average depth of snow, inches......	Direction from.			Cloud proportion scale 0-10.			Average State.
				7 A.M.....	2 P.M....	9 P.M.....	2 A.M.....	7 P.M.....	9 P.M.....	24 hours...
35.2	25.463	0.00	0.00	E	S	W	1	—	0	Clear.
38.4	25.458	0.00	0.00	W	SW	W	—	—	—	Clear.
37.3	25.413	0.00	0.00	E	SE	W	2	1	1	Clear.
28.6	25.394	0.00	0.00	SE	N	W	3	9	4	Fair.
26.6	25.359	T	0.00	E	E	N	1	9	6	Fair.
33.3	25.393	0.00	0.00	E	W	W	6	4	3	Fair.
27.9	25.393	0.00	0.00	SE	N	W	—	3	—	Clear.
28.6	25.482	0.00	0.00	SE	SE	N	—	—	0	Clear.
30.3	25.533	0.00	0.00	E	NE	SW	0	.....	0	Clear.
41.0	....	0.00	0.00	SE	.....	NW	—	—	0	Clear.
41.3	25.483	0.00	0.00	SW	W	W	0	—	0	Clear.
35.3	25.397	0.00	0.00	E	SE	NW	3	2	1	Clear.
32.2	25.418	T	0.00	E	NW	N	1	8	8	Fair.
30.7	25.454	0.00	0.00	E	S	NE	3	3	9	Fair.
27.4	25.405	0.00	0.00	E	SW	W	3	1	0	Clear.
34.5	....	0.00	0.00	SE	W	W	0	0	0	Clear.
35.0	25.431	0.00	0.00	SW	SW	W	0	0	4	Clear.
30.0	25.361	0.00	0.00	SW	E	NW	0	0	0	Clear.
36.7	25.398	0.00	0.00	N	E	N	—	—	0	Clear.
40.4	25.446	0.00	0.00	E	E	NW	—	2	3	Clear.
30.2	25.439	T	0.00	E	W	SW	1	10	3	Fair.
34.3	25.431	0.00	0.00	E	SW	W	—	—	0	Clear.
39.6	25.476	0.00	0.00	SE	S	NW	0	—	0	Clear.
39.4	....	0.00	0.00	E	SW	W	0	—	0	Clear.
39.9	25.494	0.00	0.00	E	SW	W	0	0	—	Clear.
25.8	25.416	0.00	0.00	SW	SW	W	3	5	8	Fair.
19.6	25.338	T	0.00	SW	SW	NW	5	9	3	Fair.
37.5	25.483	0.00	0.00	SE	NW	W	1	2	0	Clear.
38.7	25.502	0.00	0.00	E	SW	E	0	0	0	Clear.
39.7	25.478	0.00	0.00	E	SW	SW	—	—	0	Clear.
1003.4	686.728	Trace.	0.00	.....	.....	.....	33	69	53	....
33.44	25.434	Trace.	0.00	E	SW	W	1.1	2.3	1.7	Clear.

SUMMARY APRIL, MAY AND JUNE, 1889,

Compared with the same months of 1888.

NEVADA AGRICULTURAL EXPERIMENT STATION.

		April 1888.	April 1889.	May 1888.	May 1889.	June 1888.	June 1889.
Air pressure. Readings corrected for temp.	Highest barometer, inches	....	25.684	....	25.663	....	25.581
	Date	....	21	....	18	....	9
	Lowest barometer, inches	....	25.144	....	25.034	..,....	25.245
	Date	....	13	....	5	....	27
	Range of barometer, inches	....	.540	....	.629	....	.336
	Mean barometer, inches	....	25.432	....	25.404	....	.....
Temperature, Fahrenheit.	Highest, degrees	....	79.8	87.3	89.7	86.0	91.3
	Date	....	26	12	26	22	12
	Lowest, degrees	....	25.4	26.5	29.4	36.7	37.5
	Date	....	18	2	8	7	28
	Monthly range, degrees	....	54.4	60.8	60.3	49.3	53.8
	Mean maximum, degrees	73.97	65.4	70.21	68.8	71.57	84.57
	Mean minimum, degrees	33.88	37.8	40.74	41.8	46.17	50.70
	Greatest daily range, degs.	....	40.6	....	39.0	....	41.3
	Date	....	19	....	25	....	11
	Least daily range, degrees	....	8.5	....	10.3	....	19.6
	Date	....	5	....	6	....	27
	Mean daily range, degrees	40.09	25.432	....	25.404	....	33.44
	Mean—¼ (7+2+9+9) degs.	51.95	52.01	56.62	56.67	60.00	69.79
Mean relative humidity, per cent		53.29	42.96	44.06	43.25	39.96	32.78
Mean dew point, degrees		96.60	28.43	31.49	31.03	33.09	33.24
Total precipitation, inches		....	.03	.79	1.825	.11	T
Total snow-fall, inches		....	Trace.	0	2.25	.00	.00
Frost, number times observed		....	9	4	4	2	0
Thunderstorms, number of		....	0	3	0	.00	4
Weather.	Rainy days	0	0	0	1	0	0
	Cloudy days	3	0	5	0	2	0
	Fair days	4	17	2	12	14	22
	Clear days	23	11	22	18	14	8
	Prevailing	Clear.	Fair.	Clear.	Clear.	Clear.	Clear.
Wind. Times observed blowing from	North	....	7	4	3	2	7
	Northeast	....	4	6	5	5	3
	East	....	21	23	18	7	21
	Southeast	....	4	3	3	2	9
	South	....	1	0	3	1	3
	Southwest	....	8	11	15	16	18
	West	....	36	20	25	30	20
	Northwest	....	4	15	11	6	8
	Prevailing	....	West.	East.	West.	West.	East.
Times of calm		....	0	0	0	2	1

NEVADA
AGRICULTURAL EXPERIMENT STATION,
RENO, NEVADA.

The State Legislature, in accepting the National appropriation for an Agricultural Experiment Station, located the Station at the Nevada State University, at Reno. The Station is now being thoroughly equipped and is preparing to make a study of some of the many perplexing questions constantly presenting themselves to the farmers, gardeners and herdsmen of Nevada. These investigations will be pursued with a view to the solution of some of these questions, and the publication of the results, in the hope that the efforts put forth here may be of service in the development of the agricultural resources of our State and the advancement of the agricultural interests.

It is proposed to undertake investigations respecting: (1.) The growth of the various farm crops; (2.) The growth, treatment and food value of various forage plants and their adaptability to our soil and climate; (3.) The best varieties and most satisfactory method of growing garden vegetables; (4.) The adaptability and treatment of large and small fruits; (5.) The structure, nature and distribution of native and introduced plant; (6.) The purity and vitality of seeds; (7.) The chemical composition of feeding stuffs, soils, fertilizers and potable waters; (8.) The insects of the State and the use of insecticides and insecticide apparatus; (9.) The feeding of beef cattle and sheep; (10.) Forest trees and their care; (11.) The diseases of plants and of animals; (12.) Meteorology and soil temperature.

Any citizen of Nevada who is interested in agriculture in any of its departments, is invited to apply to the Station for any information that he may desire concerning the theory and practice of any branch of Agriculture. All such communications will receive due consideration, and, as far as possible, will be answered promptly.

Citizens of the State are invited to suggest to the Station such lines of investigation as they most desire undertaken. All suggestions of this nature will receive attention at the hands of the Station Staff, and will be acted upon so far as the means at our command will permit.

The Station desires for study and for museum purposes, samples of plants, seeds, farm crops, sections of trees, minerals, soils, abnormally developed plants and animals, etc. For any of these we will be grateful.

All communications, specimens and express packages should be addressed—

DIRECTOR EXPERIMENT STATION,
Reno, Washoe County, Nevada.

Bulletins

Of the Nevada Agricultural Experiment Station are issued quarterly, or oftener. These will be sent to all who apply for them, so long as the supply lasts. Inquiries by those interested in the work of the Station, will be replied to as promptly and fully as possible.

All communications should be addressed:

Director EXPERIMENT STATION,
Reno, Washoe County, Nevada.

Nevada Agricultu

EXPERIMENT ST

Bulletin No.

SEPTEMBER, 18

METEOROLOGICAL R

FOR

July, August and September

BY

W. S. DEVOL, B. AG.

RENO:
GAZETTE STEAM BOOK AND JOB PRIN
1889.

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[BULLETIN NO. 6.—September, 1889.]

METEOROLOGICAL REPORT

—FOR—

July, * August * and * September, * 1889.

PRINCIPAL FEATURES OF THE WEATHER FOR THE QUARTER.

ATMOSPHERIC PRESSURE. *

JULY.—The highest reading of the barometer (atmospheric pressure), in July was 25.665 inches on the 27th, and the lowest was 25.269 inches on the 5th. The range of barometer was .396 inch. This is .063 inch higher than that for June, but much lower than for April and May of the preceding quarter, and August and September of this quarter. The monthly mean for July was 25.471 inches, which is higher than the mean for either month of the preceding quarter, but lower than that for August and September. There was a gradual rise in the monthly mean barometer from May to September.

AUGUST.—The maximum atmospheric pressure during the month of August occurred on the 22d, when the reading was 25.716 inches; a rise of .051 inch above the July maximum, and .07 inch higher than the maximum for the monthly mean for the four months next preceding. The maximum barometer reading was 25.232 inches on the 24th, giving a range of .484 inch. This is a greater range than occurred in June or July; but smaller than for April, May and September. The monthly mean barometer was 25.500 inches.

SEPTEMBER.—The September maximum barometer was 25.790 inches on the 25th; a rise of .074 inch above the highest for August, .209 inch above the very low maximum for June, and .128 inch higher than the mean maximum for the four months, April—August. On the 21st the atmospheric pressure sank to 25.293 inches, the lowest reading for the month. The monthly range was .497 inch, showing the

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* The barometer readings are corrected for temperature but not for altitude.

greatest variation n atmospheric pressure during the quarter. The monthly mean for September was 25.515 inches, or a higher mean than for any other month in the two quarters. The maximum atmospheric pressure for the quarter was 25.790 inches, September 25th, and the lowest was 25.232 inches, August 24th; giving a range for the quarter of .458 inch. The mean for the quarter was 25.494 inches, and for the six months 25.470 inches.

TEMPERATURE OF THE AIR.

JULY.—This month was warmer than the same month of 1888. The maximum thermometer this year reached 100.0° on the 28th, which is 7.5° above the maximum for July, 1888. The lowest minimum temperature recorded was 44.8° on the 24th, which is 4·02° higher than the same for 1888. This makes the monthly range (55.2°) 3.3° greater than the range for July, 1888. The mean temperature for the month was 77.64°, the highest of any month of this year, and 7.02° higher than the same month in 1888. This excessively warm weather, coupled with the absence of rain, made this a very severe month on grazing lands not under irrigation. The greatest daily range of temperature was 44.30° on the 28th; the least daily range was 27.5° on the 14th; and the mean daily range was 33.50°. The warmest day was the 28th, when the mean temperature was 84.7°. There were several days just preceding and following this date, which were nearly as warm, making the week, July 25--31, the warmest of the year. The coldest day of the month was the 16th, when the mean temperature was 67.4°, making a range of 17.3° in daily mean temperature. The mean maximum was 85.4°, and mean minimum 51.9°.

AUGUST.—Although there were more records of high temperature in August than in July, the monthly mean was but 72.45°, or more than 5° less than that for July. The mean for July, 1888, was almost the same as for 1889, the difference being less than half a degree. The highest temperature was 94.5°, reached on the 14th, and the lowest was 40.8° on the 27th. The corresponding data for 1888 are, 93.1° on the 23d, and 41.2° on the 1st; the place in the month for the maximum and minimum. respectively, being reversed. The mean maximum temperature was 88.4°, which is 3° higher than for July. The greatest daily range was 46.0° on the 15th, when the temperature rose from 47.4° in the night, to 93.4° in the afternoon of the same day. The least daily range of temperature was 24.9°,on the last day of the month; the extremes on this day were a minimum of 55.9° and a maximum of 80.8°. The warmest day was 78.72° on the 15th, and the coldest 63.9° on the 19th, the extremes occurring within a period of five days, with a range of 15.82° daily mean temperature.

SEPTEMBER.—There was a greater difference between the temperatures of August and September than between July and August. The mean for September was 61.27°, or 11.18° less than that for August, against a difference of only 5.19° between July and August. On the 6th and 7th the maximum temperature was reached, when 91.1° was the record. On the 24th the lowest temperature was reached, when the minimum thermometer recorded 34.7°, giving the large monthly range of 56.4°. There were fewer very warm days than in July or August, and the mean maximum was but 80.72°. The greatest daily range of temperature was 50.7°, on the 17th, and the least 15.7°, on the 28th. The greatest for September, 1888, was 41.6°, and the least 15.1°. The mean daily range for the month in 1889 was 40°. The warmest day of the month was 74.37° daily mean temperature on the 6th, and the coldest 51.30° on the 24th, making a range in daily mean temperature ot 23.07°. The average of the temperatures recorded by the minimum thermometer was 40.72°, and the average for the maximum was 40° higher than this.

DEW POINT.

The dew point, or temperature at which dew or rain will form, is nearest the actual or air temperature when there is the greatest relative amount of moisture in the air. The highest relative daily mean dew point—i e. the dew point nearest the air temperature—for July was 48.7° on the 23d, and the lowest was 20.1° on the 6th. The highest dew point at any one observation was 55.1° at 7 A. M. on the 30th; the lowest was 4.0° at 9 P. M. the 6th. The mean dew point for the month was 37.77°.

The daily mean dew point in August which came nearest the daily mean temperature was 38.92° on the 9th; and the lowest in relation to the mean temperature was 17.23° on the 22d. The mean for the month was 31.26°.

In September the daily mean dew point approaching nearest the air temperature was 30.0° on the 23d, when the mean temperature of the air was 49.57°. The lowest in the some relation was 23.4° on the 4th; the daily mean air temperature for that date being 69.0°. The highest observed dew point was at 2 P. M. on the 25th, and was 47.2°, and the lowest was 3.8° at 9 P. M. of the 18th.

RELATIVE HUMIDITY.

The mean relative humidity for the season has been very low, and at no time in the quarter did the air at the surface of the earth approach saturation.

JULY.—The highest daily mean relative humidity for July was on the

16th, when the air was a little over half (51.9 per cent.) saturated with moisture. Upon this date the daily mean temperature was the lowest for the month, being 67.4°. The lowest daily mean relative humidity was 1.19 per cent. on the 6th. The highest observed relative humidity was 69.8 per cent. at 7 A. M. on the 26th. The mean for the 7 A. M. observations was 50.10 per cent.; for 2 P. M. 16.20 per cent.; for 9 P. M. 26.16 per cent.; for the month 30.72 per cent.

AUGUST.—The maximum August daily mean relative humidity was 40.23 per cent. on the 5th, and the lowest was 18.40 per cent. on the 2d. The highest relative humidity observed at any one time during the month was 77.2 per cent, or a little over three-fourths saturation, at 7 A. M. the 5th. The least moisture was indicated by a relative humidity of 3.5 per cent. at 2 P. M. on the 22d. The monthly mean was 28.00 per cent., indicating a dryer atmosphere than that of July.

SEPTEMBER.—For September 55.03 per cent. on the 23d, was the maximum daily mean, and 21.97 per cent. on the 14th the minimum daily mean relative humidity. The highest relative humidity for any one observation was 78.6 per cent at 7 A. M. the 23d. The lowest was at 9 P. M. on the 18th, when the per cent. was 8.6. The range, as indicated by the above, was 70.0 per cent. There was a slight increase in mean relative moisture for the month, as the monthly mean relative humidity was 32.03 per cent., which is 4.03 per cent. higher than that for July.

There was less variation from day to day in the daily mean relative humidity during September, than there was during July and August. The average relative humidity was higher during the last half than during the first half of the month.

PRECIPITATION.

The Summer has been an extremely dry one. At no time from the 16th of May to the 30th of September has a measurable quantity (.001 inch) of rain fallen at the Experiment Station, and upon one occasion only from June 27th to September 30th has a drop fallen. On the 29th of July a few scattering rain-drops fell during a brisk wind. There was not enough, however, to moisten the surface of an exposed board. This is in marked contrast with the precipitation for the same month of 1888, when several good showers were had in July and September, and two light ones in August. The precipitation for July, 1888, was .45 inch; August, .27 inch; September, .7 inch; making a total of 1.42 inches, to an inappreciable trace for the whole quarter in 1889.

From the records kept at Reno by the Central Pacific Railroad from July, 1881, to November, 1887, inclusive, (except for February to

October, 1883), the data were obtained for making the comparison of rainfall during former years with that for the quarter in 1888 and 1889, as observed at the Experiment Station.

MONTH.	EXPERIMENT STATION.		CENTRAL PACIFIC RAILROAD.				
	1888.	1889.	Average	Maximum.		Minimum.	
	Inches.	Inches.	Inches.	Inches.	Year.	Inches.	Year.
July........	0.45	0.00	0.06	0.20	1883	0.00	Frequently.
August.....	0.27	0.00	0.00	0.00	....	0.00	....
September..	0.70	0.00	0.00	0.00	....	0.00	....
	1.42	0.00	0.00	0.20	....	0.00	....

It will be seen by this table that the precipitation for this quarter in 1888 was uncommonly large, and that ordinarily there is no more rainfall than there was this year.

WIND.

The air has not been so constantly in motion during this quarter as during the last. During July there were six observations—the observations being made three times daily, viz.: At 7 A. M. and 2 and 9 P. M.—when no movement of the atmosphere could be discerned. In August there were 14, and in September 18 observations of calm. Wind force or velocity is recorded on a scale of 0 to 10; the former indicating no movement, 1 meaning a velocity of one to two miles per hour, and 10 signifying a tornado. The record for July was made from a self-registering anemometer, while the August and September records are from personal observation and estimate. The greatest velocity attained in July was 5, on the scale as explained above, at 7 A. M. the 22d; a record in this instance of a speed of 44 miles for the hour next preceding. The daily maximum velocity occurred, as a rule, during middle to late afternoon, and early evening, while of the 38 calms observed, all except 4 were at 7 A. M. On twelve other occasions a velocity or force of 5, by the scale, was observed, but on none of these was the actual miles per hour so great as upon the one above mentioned. The mean velocity at 7 A. M. was .32; at 2 P. M. 2.82; and at 9 P. M. 3.93. The greatest velocity observed in August was 6 at 2 P. M. on the 18th. On three occasions a velocity of 5 was recorded, all at 2 P. M. The mean velocity at 7 A. M. in August was .48; at 2 P. M. 2.77; at 9 P. M. 2.46.

The maximum velocity, by the scale, for September was 7 at 2 P. M. on the 20th, 21st and 27th. The maximum at 9 P. M. was 6 on the 27th; and at 7·A. M. 3 on the 13th. The mean at 7 A. M. was 0.43; at 2 P. M. 2.73; and at 9 P. M. 2.07.

The prevailing direction of the wind at the Experiment Station is from the west. Of the observations made in July on the direction of the wind, 36, or more than one-third of the times, the movement was from the west. At no time was the wind observed blowing from the west at 7 o'clock in the morning. At 2 P. M. the air movement was from the west 16 times, and at 9 P. M. 20 times. The currents were from the east 16 times—the second greatest number—and from the south-east 13 times. The prevailing direction of the wind in July at 7 A. M. was from the east, 12 times; at 2 P. M. west, 16 times; at 9 P. M. west, 20 times.

In August the prevailing direction of the wind was from the west, also; the total number of observations at which it was from this direction being 40, and the distribution being 21 at 9 P. M.; 19 at 2 P. M; and none at 7 A. M. The second greatest number of times was 10, from the north-east. The prevailing direction at 7 A. M. was from the north-east, and at 2 and 9 P. from the west.

The direction from which the currents of air moved in September was more evenly distributed among the different points of the compas, than in July and August. The prevailing direction for September was north, there having been 4 observations at 7 A. M.; 8 at 2 P. M.; and 11 at 9 P. M.; when the movement was from this direction. The current was from the west the second greater number of times. The prevailing direction at 7 A. M. was from the north and the east; at 2 P. M. from north-east; at 9 P. M. from north.

The prevailing direction for the six months ending September 30th; was from the east at 7 A. M.; from the west at 2 P. M.; and from the west at 9 P. M. The force or velocity for each day is almost invariably greater when the movement of the air is from the west.

CLOUDS.

The absence of clouds was a very noticeable feature of the weather for the quarter.

JULY.—There was not a cloudy day in the month of July. At 55 of the 93 observations not a cloud was visible. At 24 others the cloud proportion was less than one-tenth (0.1). At one time only was the sky cloudy. This was at 7 A. M. on the 16th, when the cloud proportion was .8. There was but one fair day, 16th. The 30 other days were clear.

AUGUST.—The August weather was almost as clear as that of July.

There were no cloudy, two fair and twenty-nine clear days. The greatest cloud proportion was .8 at 7 A. M., on the 9th. At 59 of the 91 observations no clouds were visible. At 8 others the cloud proportion was less than one-tenth.

SEPTEMBER —The cloud proportion was a little greater in September than the two other months of the quarter. The only cloudy days were the 27th, when the mean cloud proportion was 8.3, and the 19th, when the cloud proportion was .73. There were 5 fair and 23 clear days. At 54 of the 90 observations there was not a cloud visible. At 11 others the proportion was less than one-tenth. At seven observations the cloud proportion was nine-tenths.

FROSTS.

No frosts occurred in July and August. In September there were five frosts—on the 14th, 15th, 24th, 25th and 26th.

W. S. DEVOL,

Agriculturalist and Horticulturalist.

* * *

METEOROLOGICAL RECORD FOR JULY, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION,

Latitude, 39° 31′ 15″ N. Longitude, 119° 49 W.

Day of Month.	TEMPERATURE* AND RELATIVE HUMIDITY.†						Daily mean temperature $\frac{1}{4}(7+2+9+9)$*	Daily mean relative humidity $\frac{1}{3}(7+2+9)$†.	Maximum temperature*	Minimum temperature* . . . .
	7 A. M.		2 P. M.		9 P. M.					
	Dry bulb	Relative humidity†	Dry bulb	Relative humidity†	Dry bulb*	Relative humidity†				
1 . . .	60.8	44.0	84.2	14.6	77.4	6.8	75.95	21.80	86.5	50.4
2	65.3	25.4	81.0	11.3	72.0	15.3	72.57	17.23	84.1	50.9
3	65.7	9.7	93.6	9.4	79.8	20.1	79.72	24.73	96.1	54.0
4	64.5	65.4	91.8	9.2	79.2	17.1	78.50	30.57	93.7	58.7
5	68.4	47.6	86.4	18.2	73.4	22.7	75.40	29.50	88.1	57.6
6	62.7	39.5	82.1	9.8	69.0	8 0	70.70	19.10	85.3	49.8
7	59.5	49.5	82.6	6.0	71.1	18.3	71.07	24.60	83.5	48.3
8	62.4	40.6	84.9	12.6	71.9	29.4	72.77	27.20	85.7	50.8
9	63.8	47.6	82.9	10.6	69.1	22.1	71.22	26.77	84.7	55.2
10	54.9	44.9	81.9	7.4	71.1	17.4	69.75	23.23	83.0	49.6
11	58.3	42.3	85.7	7.3	73.1	27.9	72.55	25.83	87.4	45.5
12	61.7	42.7	86.7	8.7	72.2	19.4	73.20	23.60	87.4	48.9
13	59.5	46.7	86.4	12.3	71.1	22.8	72.07	27.27	87.9	46.7
14	60.9	33.7	80.4	23.6	66.9	33.3	68.77	30.20	82.2	54.7
15	57.7	61.6	80.6	21.8	69.9	33.1	69.52	38.83	81.4	47.7
16	59.7	53.9	76.4	24.8	66 9	17.1	67.47	51.97	80.0	48.5
17	58.6	62.2	79.4	21.9	68.9	32.9	68.95	39.00	83.0	47.9
18	60.2	50.6	85.9	19.7	73.9	29 9	73.47	33.40	87.0	48.7
19	63.5	53.5	88.9	20.7	76.0	5.3	76.10	26.50	91.0	52.6
20	64.3	61.5	86.9	19.2	75 0	21.3	75.30	34.00	98.2	56.7
21	63.1	46.0	86.2	22.8	71.7	18.9	73.17	29.23	87.0	50.9
22	62.9	43.9	85.9	29.7	73.2	41.8	73.80	45.13	86.6	54.0
23	64.1	56.0	82.9	24.1	71.0	30.0	72 27	36.70	85.0	53.9
24 . . .	55.9	57.1	85.7	19.2	70.9	24.7	70.89	33 67	86.0	44.8
25	60.6	53.6	86.9	18.3	71.9	38.3	72.82	33.40	88.9	47.9
26	61.7	69.8	91.1	24.7	79.0	34.4	70.70	42.22	92.5	53 3
27	64.8	54.8	92.8	26.2	81.9	28.8	80.35	36.60	92.8	55.3
28	70.3	53.7	96.8	10.5	86.0	43.3	84.77	35.83	100.0	55.7
29	69.8	53.4	98.8	16.2	84.9	28.5	84.10	32.37	99.9	57.6
30	68.1	63.0	95.8	13.6	81.1	23.9	81..52	33.50	96.7	61.4
31	66.1	51.1	92.7	8.3	79.7	18.3	79.55	25.90	93.9	57.3
Sums.	1939.7	1553.2	2684.1	502.5	2299 2	811.1	2168.96	959.85	2647.5	1609.0
Means	62.57	50.10	86.58	16.20	74.16	26.16	69 90	30.96	85.40	51.90

* In degrees Fahrenheit. † Per cent. § Inches. — Less than 1.

METEOROLOGICAL RECORD FOR JULY, 1889.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Range of temperature*......	Daily mean barometer ‡. ...	PRECIPITATION.		WIND.			WEATHER.				Day of Month ....
		Total amount of rain and melted snow, in inches and hundredths	Average depth of snow inches...........	Direction from			Cloud Proport'n Scale 0-10.			Average State.	
				7 A. M.........	2 P. M.......	9 P. M.........	2 P. M. ...	7 P. M........	9 P. M.........	24 hours.....	
36.1	25.509	0.00	0.00	sw	s	n	—	—	0	clear	 1
33.2	25.520	0.00	0.00	se	e	n	0	0	0	clear	 2
42.1	25.495	0.00	0.00	e	w	w	0	—	0	clear	 3
35.0	25.440	0.00	0.00	sw	w	w	0	—	—	clear	... 4
30.5	25.317	0.00	0 00	se	n	w	0	0	0	clear	 5
35.5	25.357	0.00	0.00	e	w	n	0	—	—	clear	 6
35.2	25.424	0.00	0.00	e	e	nw	0	2	0	clear	 7
34 9	25.405	0.00	0.00	nw	ne	w	—	3	3	clear	... 8
29.5	25.369	0.00	0.00	e	w	nw	—	—	1	clear	 9
33.4	25.422	0.00	0.00	e	w	w	0	0	—	clear	...10
41.9	25.439	0.00	0.00	e	se	nw	0	0	0	clear	11
38.5	25.419	0.00*	0.00	calm	w	w	0	0	0	clear	12
41.2	25.458	0.00	0.00	calm	se	w	0	0	0	clear	13
27 5	25.352	0.00	0.00	se	w	nw	0	0	0	clear	14
33.7	25.315	0.00	0.00	e	w	w	0	—	4	clear	...15
31.5	25.369	0.00	0.00	e	w	w	8	3	1	fair	16
35.1	25.498	0.00	0.00	se	w	nw	0	1	0	clear	17
38 3	25.565	0.00	0.00	se	se	nw	0	—	0	clear	...18
38.4	25.494	0.00	0.00	se	s	w	0	1	0	clear	19
41.5	25.487	0 00	0.00	s	w	w	0	—	0	clear	20
36 1	25.512	0.00	0.00	se	w	w	0	—	0	clear	21
32.6	25.466	0.00	0.00	ne	w	w	0	1	—	clear	22
31.5	25.444	0.00	0.00	se	nw	nw	—	—	0	clear	. ..23
41.2	25.459	0.00	0.00	e	se	w	0	—	0	clear	24
41.0	25.513	0.00	0.00	e	ne	n	2	—	1	clear	25
39.2	25.587	0.00	0.00	e	e	w	0	—	0	clear	26
37.5	25.601	0.00	0.00	e	se	w	0	—	0	clear	27
44.3	25.541	0.00	0.00	calm	sw	w	0	—	0	clear	28
42.3	25.459	0.00	0.00	calm	s	w	0	4	2	clear	29
35.3	25.486	0.00	0.00	calm	w	nw	0	—	0	clear	30
36.6	25.542	0 00	0.00	calm	w	w	0	0	0	clear	31
1038.5	789.631	00.0	00.0	....	...	....	10	15	12	....	Sums
33.50	25.471	00.0	00.0	e	w	w	.32	.49	.40	clear	Means

METEOROLOGICAL RECORD FOR AUGUST, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION,

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

Day of Month....	TEMPERATURE* AND RELATIVE HUMIDITY.†						Daily mean temperature ¼(7+2+9+9)*...	Daily mean relative humidity ⅓(7+2+9.)†............	Maximum temperature*....	Minimum temperature*....
	7 A. M.		2 P. M.		9 P. M.					
	Dry bulb*	Relative humidity†..........	Dry bulb*......	Relative humidity†..... ...	Dry bulb*......	Relative humidity†..				
1 ...	64.8	44.2	91.7	9.3	75.3	26.1	76.77	26.53	94.1	53.3
2....	63.8	28.6	91.8	8.8	76.0	17.8	76.90	18.40	94.2	53.5
3....	61.9	51.5	91.9	16.1	76.0	19.0	76.40	28.80	93.3	55.7
4....	60.7	45.9	89.9	11.3	75.1	21.1	75.22	26.10	91.7	54.2
5....	62.5	77.2	89.6	13.4	73.1	30.1	74.57	40.23	90.7	54.7
6....	66.1	61.1	87.9	10.5	74.9	18.5	75.95	30.03	90.6	56.9
7....	62.9	49.7	88.9	10.3	73.5	16.5	74.70	25.50	89.9	53.4
8....	65.7	57.8	85.7	19.5	74.5	19.3	75.10	32.20	87.6	58.2
9....	63.8	50.4	85.9	20.5	71.7	24.5	73.27	31.80	90.1	56.7
10....	60.9	52.7	86.8	18.8	74.7	19.8	74.12	30.43	87.4	58.6
11....	59.7	49.3	84.9	11.3	70.4	18.6	71.35	26.40	86.2	52.7
12....	59.7	63.8	81.3	12.5	69.0	21.0	69.75	32.43	88.3	50.7
13....	56.7	68.6	91.3	3.9	77.2	8.6	75.65	27.03	92.1	47.6
14....	....	....	92.8	....	76.1	8.7	.. ..	.....	94.5	47.8
15....	62.5	81.5	92.6	7.2	79.9	19.9	78.72	36.20	93.4	47.4
16....	75.6	31.0	85.7	13.7	73.9	23.5	77.27	22.73	89.4	63.8
17....	....	....	85.4	11.8	69.2	33.0	... .	.....	86.4	58.6
18....	56.8	61.4	78.8	13.8	61.8	36.6	64.80	37.26	80.4	47.9
19....	50.8	48.0	74.8	10.0	65.0	14.4	63.90	24.13	77.2	43.5
20....	51.9	50.9	85.9	12.7	72.1	21.1	70.50	28.23	87.5	42.8
21....	58.4	50.6	88.8	16.0	76.0	16.0	74.80	27.53	90.2	50.7
22....	59.9	44.3	89.7	3.5	75.3	8.4	75.05	18.73	90.4	50.8
23....	59.3	44.5	87.6	5.0	69.2	5.8	71.33	18.77	89.1	48.2
24 ...	53.1	31.5	87.9	4.1	70.1	20.0	70.30	18.53	87.1	45.0
25....	53.8	46.6	82.9	8.5	71.0	13.2	69.67	22.76	84.9	47.0
26....	54.6	36.4	81.9	8.3	66.9	24.7	67.50	23.13	83.9	45.1
27....	52.9	49.5	83.1	6.9	67.7	21.9	67.85	26.10	84.0	40.8
28....	54.5	55.3	86.7	8.9	67.0	33.8	68.80	32.66	86.7	46.0
29....	54.4	60.6	85.9	12.1	74.1	18.9	72.12	30.53	87.1	50.8
30....	56.0	50.0	87.8	11.2	72.0	21.0	71.95	27.40	88.9	51.9
31....	59.8	46.6	78.1	15.5	64.5	32.5	66.72	31.53	80.8	55.9
Sums.	1723.7	1489.5	2673.0	335.0	2233.3	717.0	2101.03	802.10	2743.1	1591.3
Means	59.4	51.3	86.2	11.2	72.0	23.13	72.45	28.00	88.4	51.3

* In degrees Fahrenheit. † Per cent. § Inches. — Less than 1.

METEOROLOGICAL RECORD FOR AUGUST, 1889.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Range of temperature*......	Daily mean barometer †. ...	PRECIPITATION.		WIND.			WEATHER.				Day of Month...........
		Total amount of rain and melted snow, in inches and hundredths	Average depth of snow inches...........	Direction from			Cloud Proport'n. Scale 0-10.			Average State.	
				7 A. M.........	2 P. M.........	9 P. M.........	7 A. M.	2 P. M.........	9 P. M.........	24 hours......	
40.8	25.551	0.00	0.00	e	w	w	0	0	0	clear	 1
40.7	25.590	0.00	0.00	ne	w	w	0	0	0	clear	 2
37.6	25.523	0.00	0.00	e	se	sw	0	0	0	clear	 3
37.5	25.541	0.00	0.00	ne	w	nw	0	0	0	clear	 4
36 0	25.505	0.00	0.00	0	w	ne	0	2	3	clear	 5
33.7	25.451	0.00	0.00	0	w	w	0	1	1	clear	 6
36.5	25.413	0.00	0.00	nw	w	w	2	1	5	clear	 7
29.4	......	0.00	0.00	0	e	w	1	1	7	clear	... 8
33.4	25.796	0.00	0.00	0	sw	nw	8	3	2	fair	 9
28.8	25.464	0.00	0.00	0	0	w	2	3	4	clear	...10
33.5	25.458	0.00	0.00	ne	w	w	0	0	1	clear	11
37.6	25.438	0.00	0.00	0	w	n	0	0	0	clear	12
44.5	25.427	0.00	0.00	0	w	w	0	0	0	clear	13
46.7	25.504	0.00	0.00	....	sw	nw	....	1	0	clear	14
46.0	25.516	0.00	0.00	0	w	w	0	6	7	fair	15
25.6	25.466	0.00	0.00	ne	w	sw	4	4	—	clear	16
27.8	......	0.00	0.00	....	w	w	....	5	0	clear	17
32.5	25.409	0.00	0.00	nw	w	w	0	—	0	clear	18
33 7	25.503	0.00	0.00	s	s	n	—	—	0	clear	19
44.7	25.511	0 00	0.00	ne	se	nw	0	0	0	clear	20
39.5	25.565	0.00	0.00	calm	ne	w	0	0	0	clear	21
39.6	25.602	0.00	0.00	ne	nw	w	0	0	0	clear	22
40.9	25.419	0.00	0.00	calm	w	w	0	0	0	clear	. ..23
42.1	25.349	0.00	0.00	se	e	w	0	0	0	clear	24
37.9	25.384	0.00	0.00	calm	w	w	0	—	0	clear	25
38.8	25.344	0.00	0.00	e	w	w	0	0	0	clear	26
43.2	25.350	0.00	0.00	e	w	w	0	0	0	clear	27
40.7	25.371	0.00	0.00	e	se	ne	1	—	0	clear	28
36.3	25.377	0.00	0.00	ne	se	w	0	—	0	clear	29
37.0	25.325	0.00	0.00	se	w	w	0	0	0	clear	30
24.9	25.351	0.00	0.00	calm	w	w	0	—	0	clear	31
1151.8	738.503	00.0	00.0	....	...	....	16	27	30	....	Sums
37.1	25.500	00.0	00.0	e	w	w	.5	.9	1.0	clear	Means

METEOROLOGICAL RECORD FOR SEPTEMBER, 1889.

NEVADA AGRICULTURAL EXPERIMENT STATION,

Latitude, 39° 31′ 15″ N. Longitude, 119° 49′ W.

Day of Month.	Temperature* and Relative Humidity.†						Daily mean temperature ¼(7+2+9+9)*	Daily mean relative humidity ⅓(7+2+9)†	Maximum temperature*	Minimum temperature*
	7 A. M.		2 P. M.		9 P. M.					
	Dry bulb*	Relative humidity†	Dry bulb*	Relative humidity†	Dry bulb*	Relative humidity†				
1	51.7	46.9	73.9	19.5	62.7	26.5	62.75	30.30	75.2	44.3
2	56.9	45.0	86.7	13.9	75 9	19.5	73.85	26.13	87.7	......
3	60.5	45.7	87.1	16.3	72.9	28.4	73.35	30.13	89.1	......
4	57.7	47.0	82.9	9.9	67.7	14.1	69.00	23.85	89.4	......
5	54.2	53.2	87.9	12.3	76.9	14.5	73.97	26.66	90.8	......
6	59.8	44.5	87.9	9.3	74.9	12.5	74.37	22.66	91.1	......
7	55.9	46.2	86.9	15.3	74.7	18.3	73.05	26.03	91.1	......
8	55.7	50.9	81.8	13.6	71.7	14.7	69.92	26.40	81.8+	......
9	54.0	64.0	79.9	11.3	66.9	23.9	66.92	33 06	89.9+	......
10	53.5	46.9	70.0	26.0	57.5	33.5	59.62	35.46	70.0+	......
11	47.5	51.8	71.1	35.9	57.9	36.0	58.75	41.23	71.1+	37.2
12	45.8	66.0	74.9	18.7	58.8	32.4	56.57	39.03	74.9+	37.5
13	51.4	25.8	67.3	14.4	40.7	47.6	53.52	29.43	67.3+	......
14	47.5	31.5	65.7	21.3	56 9	13.1	56.75	21.97	65.7+	36.1
15	48.9	45.5	76.1	24 8	61.7	32 9	62.10	34.35	76.1+	35.9
16	49.7	56.5	79.9	12.2	68.0	21.2	66.85	32.96	79.9+	......
17	49.5	52.3	81.3	14.0	64.9	14.7	65.05	27.00	86.2	......
18	48.2	46.3	84.5	23.9	68.7	8.6	65.16	26.26	84.5+	43.1
19	50.9	35.9	81.8	13.8	68.7	24.8	67.35	24.83	84.4	44.8
20	55.7	51.7	77.5	22.0	61.7	41.9	64.15	38.53	77.5+	51.0
21	46.7	75.8	74.7	18.6	56.9	34.2	58.86	42.87	75.4	39.9
22	48.6	50.6	71.1	14.7	54.8	21.6	57.37	28.97	73.3	41.7
23	41.2	78.6	61.5	38.5	47.8	48 0	49 57	55.03	62.1	35.8
24	42.2	49.0	65.6	31.2	48.7	26.2	51.30	35.47	64.5	34.7
25	42.7	64.1	72.9	40.4	54.5	20.7	56.15	41.73	74.0	35.6
26	43.7	37.1	77.2	11.6	58.7	24.5	59.57	24.40	79.5	36.0
27	45.7	43.1	78.1	23.5	66.8	16 8	62.75	27.80	79.3	40.9
28	59.2	24.2	68 6	15.3	58.7	30.4	61.37	23.30	70.4	54.7
29	44.9	65.4	76.6	22.3	63.0	46.8	61.87	44.83	76.7	42.3
30	48.8	70.6	80.9	27.2	67.7	23.1	66 27	40.30	82.8	41.4
......		......	......		......	......	....	.	......	......
Sums.	1518.7	1512.1	2312.6	591.7	1887.4	771.7	1838.13	960.91	2451.7	739.9
Means	50.29	50.40	77.09	19.72	62.91	25.72	61 27	32.03	80.72	40.72

* In degrees Fahrenheit. † Per cent. § Inches. — Less than 1.
+ Maximum reading of exposed thermometer (dry bulb).

METEOROLOGICAL RECORD FOR SEPTEMBER, 1889.

RENO, WASHOE COUNTY, NEVADA.

Altitude, 4,552 feet. 120th W. Meridian Time.

Range of temperature*	Daily mean barometer ‡ ...	PRECIPITATION.		WIND.			WEATHER.				Day of Month ....
		Total amount of rain and melted snow, in inches and hundredths	Average depth of snow inches..........	Direction from			Cloud Proport'n. Scale 0-10.			Average State.	
				7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	24 hours......	
30.9	25.545	0.00	0.00	ne	e	w	0	0	0	clear	 1
....	25.450	0.00	0.00	calm	e	w	0	1	4	clear	 2
....	25.445	0.00	0.00	ne	n	nw	1	—	0	clear	 3
....	25.508	0.00	0.00	ne	ne	nw	3	—	—	clear	 4
....	25.470	0.00	0.00	calm	n	w	2	—	0	clear	 5
....	25.467	0.00	0.00	e	e	w	0	0	0	clear	 6
....	25.464	0.00	0.00	calm	sw	w	1	—	0	clear	 7
....	25.437	0.00	0.00	sw	e	w	0	0	0	clear	... 8
...	25.377	0.00	0.00	sw	sw	w	0	0	0	clear	 9
....	25.438	0.00	0.00	se	n	n	0	0	0	clear	...10
33.9	25.440	0.00	0.00	ne	se	nw	0	—	0	clear	11
37.5	25.401	0.00	0.00	calm	ne	calm	0	0	2	clear	12
...	25.409	0.00	0.00	n	ne	n	0	8	0	clear	13
29.6	25.588	0.00	0.00	n	n	n	—	0	0	clear	14
40.2	25.617	0.00	0.00	calm	n	n	0	0	0	clear	15
....	25.568	0.00	0.00	n	n	n	0	—	0	clear	16
....	25.532	0.00	0.00	calm	n	n	0	0	0	clear	17
41.4	25.553	0.00	0.00	calm	e	n	2	9	2	fair	18
39.6	25.471	0.00	0.00	calm	e	w	9	9	4	cloudy	19
26.5	25.397	0 00	0.00	calm	sw	w	9	9	0	fair	20
35.5	25.332	0.00	0.00	nw	sw	nw	8	7	0	fair	21
31.6	25.430	0.00	0.00	se	se	n	0	0	0	clear	22
26.3	25.648	0.00	0.00	n	ne	n	—	0	0	clear	. ..23
29.8	25.751	0.00	0.00	calm	e	n	0	0	0	clear	24
38.4	25.731	0.00	0.00	calm	ne	nw	0	0	0	clear	25
43.5	25.683	0.00	0.00	calm	n	n	—	0	0	clear	... 26
38 4	25.592	0.00	0.00	calm	w	w	8	8	9	cloudy	27
15.7	25.597	0.00	0.00	w	w	calm	9	9	0	fair	28
34.4	25.591	0.00	0.00	calm	w	calm	6	4	0	fair	29
41.4	25.534	0.00	0.00	calm	e	s	—	0	0	clear	30
....	.....	....	....	....	....	....	....	....	....	....	.....
1711.8	765.466	00.0	00.0	....	...	....	58	64	21	....	Sums
40.0	25.515	00.0	00.0	n	e	n	1.93	2.13	0.7	clear	Means

METEOROLOGICAL SUMMARY—JULY, AUGUST AND SEPTEMBER, 1889,

Compared with the same months of 1888.

NEVADA AGRICULTURAL EXPERIMENT STATION.

		JULY.		AUGUST.		SEPTEMBER.	
		1888.	1889.	1888.	1889.	1888.	1889.
Air Pressure. Readings corrected for temp	Highest barometer, inches.	......	23.665	......	25.716	......	25.790
	Date	......	27	......	22	......	25
	Lowest barometer, inches.	......	25.269	......	25.232	......	25.293
	Date	......	5	......	24	......	21
	Range of barometer, inches.	......	.396	......	.484	.....	.497
	Mean barometer, inches.	......	25.471	.....	25.500	......	25.515
Temperature (Fahrenheit).	Highest, degrees	92.5	100.0	93.1	94.5	93.0	91.1
	Date	18	28	23	14	3	6 & 7
	Lowest, degrees	40.6	44.8	41.2	40.8	42.4	34.7
	Date	10	24	1	27	29	24
	Monthly range, degrees	51.9	55.2	51.9	53.7	50.6	56.4
	Mean maximum, degrees	85.53	85.40	86.97	88.40	82.82	80.72
	Mean minimum, degrees	51 61	51.90	50.88	51.30	50.14	40.72
	Greatest daily range, degs.	43.2	44.3	45.9	46.0	41.6	50.7
	Date	10	28	25	15	4	17
	Least daily range, degrees.	21.8	27.5	18.3	24.9	15.1	15.7
	Date	21	14	30	31	23	28
	Mean daily range, degrees.	33.92	33.50	36.09	37.16	32.68	40.00
	Mean—¼(7+2+9+9), degs.	70.62	77.64	72.04	72.45	67.46	61.27
Mean relative humidity, per cent.		32.02	30.72	30.65	28.00	42.52	32.03
Mean dew point, degrees		34.54	37.77	34.20	31.26	39.43	29.00
Total precipitation, inches		0.45	0.00	0.27	0.00	0.70	0.00
Total snowfall, inches		0.00	0.00	0.00	0.00	0.00	0.00
Frost, number of times observed.		0	0	0	0	0	5
Thunderstorms, number of.		5	1	2	0	5	0
Weather.	Rainy days	7	0	1	0	5	0
	Cloudy days	0	0	0	0	0	2
	Fair days	12	1	3	2	10	5
	Clear days	19	30	28	29	20	23
	Prevailing	clear	clear	clear	clear	clear	clear
Wind; times observed blowing from	North	3	3	0	2	4	23
	Northeast	4	1	3	10	5	9
	East	13	15	23	8	16	9
	Southeast	6	13	5	5	2	4
	South	5	4	0	2	2	1
	Southwest	24	2	25	4	25	6
	West	26	36	29	40	27	14
	Northwest	7	11	3	7	6	6
Times of calm		2	6	5	14	3	18

TEMPERATURE SUMMARY,

For the Six Months ending September 30, 1889.

		Degrees.	Date.
APRIL.	Highest maximum	79.8	26th
	Lowest maximum	48.9	14th
	Highest minimum	46.9	8th
	Lowest minimum	25.4	18th
	Greatest daily range	40.6	19th
	Least daily range	8.5	5th
	Mean daily range	24.43	....
	Monthly range	54.40	....
	Monthly mean	52.01	....
MAY.	Highest maximum	89.7	26th
	Lowest maximum	43.6	6th
	Highest minimum	52.9	29th
	Lowest minimum	29.4	8th
	Greatest daily range	39.0	23rd
	Least daily range	10.3	6th
	Mean daily range	25.40	....
	Monthly range	60.30	....
	Monthly mean	56.67	....
JUNE.	Highest maximum	91.3	12th
	Lowest maximum	67.2	27th
	Highest minimum	58.6	4th
	Lowest minimum	37.5	28th
	Greatest daily range	41.3	11th
	Least daily range	19.6	27th
	Mean daily range	33.44	....
	Monthly range	53.80	....
	Monthly mean	69.79	....
JULY.	Highest maximum	100.0	28th
	Lowest maximum	80.0	16th
	Highest minimum	61.4	30th
	Lowest minimum	44.8	24th
	Greatest daily range	42.4	29th
	Least daily range	27.5	14th
	Mean daily range	33.50	....
	Monthly range	55.20	....
	Monthly mean	77.64	....
AUGUST.	Highest maximum	94.5	14th
	Lowest maximum	77.2	19th
	Highest minimum	63.8	16th
	Lowest minimum	40.8	27th
	Greatest daily range	46.7	14th
	Least daily range	24.9	31st
	Mean daily range	37.16	....
	Monthly range	53.70	....
	Monthly mean	72.45	....
SEPTEMBER.	Highest maximum	91.1	6th & 7th
	Lowest maximum	62.1	23rd
	Highest minimum	54.7	28th
	Lowest minimum	34.7	24th
	Greatest daily range	50.7	17th
	Least daily range	15.7	28th
	Mean daily range	40.00	....
	Monthly range	56.40	....
	Monthly mean	61.27	......

DIRECTION OF WIND,

As observed at the

NEVADA AGRICULTURAL EXPERIMENT STATION.

		TIMES OBSERVED BLOWING FROM								Times calm.	Prevailing..
		N	NE	E	SE	S	SW	W	NW		
April.	7 A. M.	2	3	11	0	0	5	8	1	0	E
	2 P. M.	0	2	6	4	1	3	11	1	0	W
	9 P. M.	5	0	4	0	0	0	18	3	0	W
	Total	7	5	21	4	1	8	37	5	0	W
May.	7 A. M.	1	4	13	1	0	4	2	2	1	E
	2 P. M.	2	1	2	2	0	11	7	2	0	SW
	9 P. M.	2	1	1	0	1	1	16	8	0	W
	Total.	5	6	16	3	1	16	25	12	1	W
June.	7 A. M.	1	1	16	6	0	5	1	0	0	E
	2 P. M.	2	1	4	3	3	10	4	2	1	SW
	9 P. M.	4	1	1	0	0	3	15	6	0	W
	Tota	7	3	21	9	3	18	20	8	1	W
July.	7 A. M.	0	1	12	8	1	2	0	1	6	E
	2 P M.	0	1	3	5	3	0	16	2	0	W
	9 P. M.	3	0	0	0	0	0	20	8	0	W
	Total	3	2	15	13	4	2	36	11	6	W
August.	7 A. M.	0	7	5	2	1	0	0	2	13	NE
	2 P. M.	0	1	3	3	1	2	19	1	1	W
	9 P. M.	2	2	0	0	0	2	21	4	0	W
	Total.	2	10	8	5	2	4	40	7	14	W
September	7 A. M.	4	4	1	2	0	2	1	1	15	N&E
	2 P. M.	8	5	8	2	0	4	3	0	0	NE
	9 P. M.	11	0	0	0	1	0	10	5	3	N
	Total.	23	9	9	4	1	6	14	6	18	N
Total for six months ending September 30, 1889		47	34	90	78	12	54	172	49	40	W

Prevailing for six months—At 7 A. M., east; 2 P. M. west; 9 P. M., west.

THE SUNSHINE RECORDER.

This was constructed during the latter part of August, with a few alterations, from plans furnished us by the Maryland Agricultural Experiment Station. By it a continuous record of the sunshine for the day is made, depending upon the action of the sun's rays upon sensitive paper. The apparatus consists of a light-tight rectangular tin box, ten inches long, by six by five inches. In the centre of one end is fixed a Waterbury photographer's lens of four and one-half inches focal length. Over the other end is fitted a tin cap or cover, projecting down the sides of the box about an inch. In this cover is placed the sensitive paper, which is held in position by a frame one-half of an inch wide. cut from sheet zinc, fitting into the cover over the paper.

When the cover is in place, this frame comes in contact with, and is held in position by the sides of the box. These are bent in at right-angles, extending abont three-eighths of an inch, forming a firm support for the zinc frame and paper, preventing them from falling within the box. This box is supported by a frame-work consisting of two posts, placed at a distance of three feet from each other on the meridian. On these posts at a height of three feet is a horizontal board four feet long, by seven by one and one-half inches. Near its north end is placed an upright board two feet long and seven inches wide. This supports an inclined board seven inches wide, resting upon the horizontal board. The angle between the inclined and horizontal boards depends upon the latitude, as the inclined board should be parallel to the axis of the earth.

In the lower end of the inclined board is a slot in which a wooden clamp for supporting the reflector is fastened. The reflector consists of a glass sphere three and one-quarter inches in diameter. A round bottomed flask will do, coated on the inside with black japan to make a more perfect reflector. The tin box is fastened securely on the upper end of the inclined board, the lens directed downwards. The distance between the lens and the reflector is ten inches. There is no arrangement for focusing the lens, but that is not necessary if the box is made with reference to the focal length of the lens with the reflector at the desired distance. The focus can be changed slightly by moving the support and reflector up or down in the slot.

The sun's rays striking the reflector are thrown up through the lens, and brought to a focus on the sensitive paper, silver paper being used. This bright spot of light blackens the paper, and changes its position corresponding to the different elevations of the sun, thus forming a dark trace or arc on the paper. An arc of a circle two and one-half inches in diameter is made with the reflector mentioned. If the arc is continuous, it represents continued sunshine throughout the day; but if broken and disconnected it represents the obscurity of the sun by clouds; the length of the spaces or breaks depends upon the length of time the sun was obscured.

The time and duration of cloudiness is determined by taking the centre of the arc, which represents twelve o'clock, noon, and then marking off the hours from this point, on either side, with a protractor, allowing fifteen degrees to the hour. If the line through the centre of the reflector and the lens is not parallel to the axis of the earth, equal spaces of the arc will not represent the same length of time.

By this apparatus the number of hours of sunshine only is definitely recorded. The different intensities of sunshine shown by the different shades of the arc must be determined by observation.

The whole apparatus is painted black to prevent reflection of light from other parts than the reflector.

NEVADA

AGRICULTURAL EXPERIMENT STATION,

RENO, NEVADA.

The State Legislature, in accepting the National appropriation for an Agricultural Experiment Station, located the Station at the Nevada State University, at Reno. The Station is now well equipped, and is making a study of some of the many perplexing questions constantly presenting themselves to the farmers, gardeners and herdsmen of Nevada. These investigations will be pursued with a view to the solution of some of these questions, and the publication of the results, in the hope that the efforts put forth here may be of service in the development of the agricultural resources of our State and the advancement of the agricultural interests.

Investigations are in progress respecting: (1.) The growth of the various farm crops; (2.) The growth, treatment and food value of various forage plants and their adaptability to our soil and climate; (3.) The best varieties and most satisfactory method of growing garden vegetables; (4.) The adaptability and treatment of large and small fruits; (5.) The structure, nature and distribution of native and introduced plant; (6.) The purity and vitality of seeds; (7.) The chemical composition of feeding stuffs, soils, fertilizers and potable waters; (8.) The insects of the State and the use of insecticides and insecticide apparatus; (9.) Forest trees and their care; (10.) The diseases of plants and of animals; (11.) Meteorology and soil temperature. It is proposed to extend the work into other fields.

Any citizen of Nevada who is interested in agriculture in any of its departments, is invited to apply to the Station for any information that he may desire concerning the theory and practice of any branch of Agriculture. All such communications will receive due consideration, and, as far as possible, will be answered promptly.

Citizens of the State are invited to suggest to the Station such lines of investigation as they most desire undertaken. All suggestions of this nature will receive attention at the hands of the Station Staff, and will be acted upon so far as the means at our command will permit.

The Station desires for study and for museum purposes, samples of plants, seeds, farm crops, sections of trees, minerals, soils, abnormally developed plants and animals, etc. For any of these we will be grateful.

All communications, specimens and express packages should be addressed,

DIRECTOR EXPERIMENT STATION,
Reno, Washoe County, Nevada.

BULLETINS

Of the Nevada Agricultural Experiment Station are issued quarterly, or oftener. These will be sent free to all who apply for them, so long as the supply lasts. Inquiries by those interested in the work of the Station, will be replied to as promptly and fully as possible.

All communications should be addressed:

DIRECTOR EXPERIMENT STATION,
Reno, Washoe County, Nevada.

(BULLETIN NO. 7.)

NEVADA

Agricultural * Experiment * Station.

DECEMBER, 1889.

Meteorological Report for October, November and December, 1889.

BY

W. S. DEVOL, B. Ag.,
AGRICULTURIST AND HORTICULTURIST.

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BULLETIN NO. 7—December, 1889.

METEOROLOGICAL REPORT

FOR

October, November and December, '89.

PRINCIPAL FEATURES OF THE WEATHER FOR THE QUARTER.

ATMOSPHERIC PRESSURE.*

OCTOBER.—This month there was a notable range in atmospheric pressure—.706 inch—the greatest since March. The mean atmospheric pressure was 25.462 inches, the lowest since March, when the mean was 25.400 inches. The highest reading was 25.751 inches on the last day of the month at 7 o'clock in the morning. The lowest reading was 25.045 inches at 2 o'clock in the afternoon of the 20th. The gradual rise in the barometer that was noted from May to September, inclusive, was interrupted by the low mean for October; but rose again in November. The low atmospheric pressure was accompanied with rainy and cloudy weather, as shown in the paragraph on precipitation.

NOVEMBER.—The mean barometer reading for November was higher than for any month since February, being 25.548 inches. The maximum was 25.864 inches at 7 A. M. on the 1st, the highest observation since the record has been kept here. The lowest or minimum pressure was 25.159 inches at 2 P. M. the 18th, making a range of .705 inch, which is .001 inch less than that for October.

DECEMBER.—The mean atmospheric pressure for December was lower than for any other month since the readings have been taken here—a period of fourteen months. It was 25.327 inches. The greatest air pressure was at 7 A. M. on the 29th, when the reading was 25.741 inches; the least was at 2 P. M. on the 21st, the reading on this date being 25.031 inches. This was the lowest reading since March. The monthly range (.710 inch) was greater than for any other period since March. This period of low barometer was accompanied by a high relative humidity and much cloudy and rainy or snowy weather.

TEMPERATURE OF THE AIR.

OCTOBER.—The highest temperture for this month was 85.6° on the 6th, which is 2.7° higher than for October, 1888. The lowest was 24.0°, on the 30th, which is 3.3° lower than the lowest for October, 1888, and makes a range of 61.6°, the greatest monthly range since April, 1888. The greatest daily range of temperature occurred on the 2d, when there was a difference of 47.4° between the maximum and minimum temperatures. The least daily range was 12.4°, on the 8th. The mean of the daily maximum temperatures for the month was 63.60°, and the mean minimum 36.68°, giving a mean daily range of temperature of 26.92°, about 4.5° less than the same for 1888. The 4th was the warmest day of the month, upon which date the mean temperature was 64.10°. The coldest day of the month occurred on the 28th, when the daily mean temperture was 37.57°. The mean temperature for the month was 50.35°, which is 3.48° cooler than the mean for 1888.

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* The barometer readings are corrected for temperature, but not for altitude.

November.—There was a slight fall in temperature during November. The maximum temperature was 65.1° on the 9th, which is 10.5° lower than for the preceding month, and 4° lower than the November, 1888, maximum. The minimum temperature was reached on the 4th, when the lowest record was 16.1°. This is lower by .9° than was reached in November, 1888. The range of temperature for the month was but 49.°. The greatest daily range was 41.3°, on the 16th, the maximum and minimum temperatures for that day being 60.8° and 19.5°, respectively. The least daily range was 7.2°, on the last day of the month, when it was very foggy. The monthly range of the maximum temperature was 26.4°, and the mean of the daily maximums for the month was 53.57°. The monthly range of the minimum temperatures was 25.1°, and the mean minimum was 26.9°. The 21st was the warmest day of the month, on which date the daily mean temperature was 50.55°. The coldest day was on the 24th, three days later, when the daily mean temperature was 33.02°, making a range of 17.53° in daily mean temperature. The mean daily range of temperature was 23.36°, and the mean temperature for the month was 39.75, or a little more than ten degrees colder than October; but less than half a degree's variation from the mean temperature for the same month in 1888.

December.—The mean temperature for the month was 31.99°, a fall of nearly eight degrees below that of the preceding month, and nearly six degrees below the mean temperature for December, 1888. The maximum temperature. reached on the 2d, was 51.8°, which is 13.3° lower than the November maximum and nearly eight degrees below the December, 1888, maximum. The minimum temperature, also, was much below the December, 1888, minimum. The lowest temperature in December of last year was 22.4°, but on the 29th of December, 1889, the minimum temperature was 7.3° below zero, or 29.7° colder than last year. The greatest range of temperature in any one day was 28°, on the 30th, and the least range, 6°, on the 14th and 26th. The mean daily range was 14.52°, and the range for the month 59.1°. In December, 1888, the monthly range was but 37.3°. The 1st, 2d, 3d and 10th were the warmest days of the month, the mean temperatures for those dates being 40.75°, 44.15°, 43.05° and 41.70° respectively. The mean temperature on the 29th was 8.67°, this being the coldest day by nearly eight degrees.

DEW POINT.

October.—The difference between the mean dew point and the mean temperature for October (17.85°) was much less than for any of Summer months, and but a little more than half what it was in October. The mean dew point for the month was 32.50°. The daily mean dew point was nearest the daily mean air temperature on the 22d, when the former was but 3.4° lower than the latter. The greatest difference between the dew point and air temperature was on the 3d, the temperature for this date being 58.82° and mean dew point 18.93°, making a difference of 38.89°.

November.—For November there was still less difference (10.62°) between the mean due point and mean temperature. The mean dew point was 29.22°, which is 2.55° higher than for November, 1888. On the 30th there was a heavy fog, and the mean dew point was the same as the air temperature. The dew point was farthest from the air temperature on the 16th, the difference between them on this date being 22.12°.

December.—The mean dew point for December (26.64°) was but 5.35° below the mean temperature, and at four observations the dew point was the same as the actual temperature, the atmosphere being at complete saturation. At no time during the month was the dew point much below the air temperature.

RELATIVE HUMIDITY.

October.—There was an increased relative humidity during October, accompanied with a rainfall that is very encouraging to agriculture. The mean relative humidity for the month was 54.24 per cent., which is more than 10 per cent. greater than for October, 1888. The greatest daily mean relative humidity was 85.6 per cent. on the 22d, upon which day there was a light rain at various intervals throughout the day. The highest relative humidity at any one observation was 94.5 per cent. at

7 A. M. of the same day. The lowest daily mean relative was 20.5 per cent. on the 3d, and the lowest at any one observation was 11.8 per cent. at 2 P. M. of the same date. The means for 7 A. M., 2 P. M. and 9 P. M. were 67.69 per cent., 40.58 per cent. and 56.09 per cent. respectively.

NOVEMBER.—The mean relative humidity for November was still higher than that for October by 14.24 per cent., the mean for the month having been 68.48 per cent. For November, 1888, the mean was 61.48 per cent., or 7 per cent. below what it was this year. The maximum daily mean relative humidity was 100 per cent. on the last day of the month, when there was a dense fog all day. The lowest daily mean was 46.43 per cent. on the 16th, making a range of 54.57 per cent. The greatest relative humidity at any one observation was 100 per cent. at each observation on the 30th. The least relative humidity was 12.8 per cent. on the 8th, making an observed range of 87.2 per cent. during the month. The means at 7 A. M., 2 P. M. and 9 P. M. were 78.75 per cent., 58.92 per cent. and 69.94 per cent., respectively, the variation in means for the different observations being somewhat less than for October.

DECEMBER.—The December mean relative humidity was 81.09 per cent., an increase of 12.61 over that of the preceding month, and 16.94 above that of December, 1888. At four observations the saturations of the air was complete, the relative humidity standing at 100 per cent., viz.: on the 1st, 23d and 24th at 7 A. M., and at 2 P. M. on the 24th. The lowest observed relative humidity was 34.4 per cent. at 2 P. M. the 15th. The lowest daily mean relative humidity—*i. e.*, the dryest day—was 56.1 per cent., the 20th. The highest daily mean was 96.66, the 23d. The very high relative humidity resulted in frequent rain and snow.

PRECIPITATION.

OCTOBER.—The quarter opened with better promise for water than last year. There was but a trace of precipitation in October, 1888, but this year there was a total of .362 inch during the month. The first rainfall was on the 7th, when an inappreciable amount fell. Amounts sufficient to measure fell on the 18th, 20th, 21st, 22d, 26th and 28th, and an inappreciable amount on the 23d, making a total of eight days upon which rain fell, against two days in 1888. The mean rainfall for October, at Reno, as obtained by the Central Pacific Railroad for a period of six years, is 0.1 inch, which is less than one-third of what it was this year. Frequently no rain at all fell during the month, and the maximum was 0.6 inch in 1883.

NOVEMBER.—The rainfall for November, 1888, was 1.95 inches, which is 0.4 inch above the maximum for the six years next preceding this. In 1889 the total precipitation was 1.735 inches, or nearly 0.2 inch above the maximum prior to 1888. Rain fell upon six days during November, 1889, and upon five of these in sufficient amount to be measured. On the 19th snow fell to the depth of 0.5 inch. All the rain fell during the last half of the month, and it closed rainy. The heaviest rain was 0.735 inch, on the 18th. The mean rainfall for six years, ending in 1887, as observed by the Central Pacific Railroad at Reno, was 0.5 inch. The maximum during that period was 1.55 inches, in 1885. Frequently no rain at all fell during the month.

DECEMBER.—The precipitation for the month was very gratifying, more especially so on account of such a large part of it being in the form of snow. There was some precipitation on twenty-two days during the month, and on sixteen of them there was a large enough amount to measure (.01 inch or more). The total precipitation for the month was 2.305 inches, rain and melted snow. The snowfall was 24.52 inches, eight inches remaining on the ground at the close of the month. In 1888 there were but ten days upon which there was any precipitation, and the total for the month was but .70 inch, including 1.6 inches snow. The greatest snowfall was from the 21st to the 25th, inclusive, during which time snow fell to the depth of 21.3 inches, 9 inches falling on the 24th. The greatest precipitation, however, was .48 inch on the 1st. The mean daily snowfall for the month was .79 inch.

MONTH.	Experiment Station.		Central Pacific Railroad—1881-1887.				
	1888.	1889.	Average.	Maximum.		Minimum.	
	Inches.	Inches.	Inches.	Inches.	Year.	Inches.	Year.
October	Trace.	0.362	0.10	0.60	1883.	0.00	frequently
November	1.95	1.735	0.50	1.55	1885.	0.00	frequently
December	0.70	2.305	0.41	0.80	1881.	0.00	82 and '83
	2.85	4.402	1.01	2.95	--------	0.00	

The record of the precipitation for the quarter, as kept since 1881 by the Central Pacific Railroad Company and the Experiment Station, is presented in tabular form. It will be seen that the precipitation is now greater than formerly, that for this year being more than four times the average, and nearly double the total maximums for the three months. Frequently there has been no precipitation in October and November, and there was none in December in 1882 and 1883.

WIND.

Ordinarily, in speaking of the force and velocity of the wind, people have a very vague and undefined idea as to the real significance of the terms used. Comparatively few people know that certain terms have been adopted by which the wind forces and velocities as indicated by miles per hour are designated. In order that greater uniformity may be attained in the use of terms the scale of wind force and velocity as used in the Signal Service is here given:

SCALE OF WIND FORCE AND VELOCITY.

FORCE.	Velocity.	Designations.
0	0	Calm.
1 2	1 to 5 miles per hour	Light.
3	6 to 14 miles per hour	Fresh.
4	15 to 24 miles per hour	Brisk.
5	25 to 39 miles per hour	High.
6	40 to 59 miles per hour	Gale.
7	60 to 79 miles per hour	Strong gale.
8	80 to 89 miles per hour	Storm.
9 10	90 or more miles per hour	Hurricane.

OCTOBER.—During the month of October there were 14 observations of "calm," 52 observations of "light wind," 8 of "fresh wind," 12 of "brisk wind," 2 of "high wind," 2 of "gale," and 3 of "strong gale," as made from the personal observation and estimation of the wind velocity. The observations of "strong gale" were at 2 P. M. on the 1st, 2 P. M. on the 7th, and 9 P.M. on the 29th. The average wind force at 7 A. M. was 1.1; at 2 P. M. it was 2.6; at 9 P. M. it was 1.8.

NOVEMBER.—The number of observations in November at which there was no perceptible movement of the wind, and "calm" was recorded was 18, an increase of 4 over October. In 1888 there was no observation of "calm" in November. The other observations for November, 1889 were as follows: "Light wind," 51 times; "fresh wind," 9 times; "brisk wind," 4 times; "high wind," 2 times; "gale," 2 times, and "strong gale," 4 times. The observations of "strong gale" were at 2 P. M. on the 12th, 17th and 19th, and at 9 P. M. on the 19th.

The total wind movement for the month (except for the six days, 21st to 26th, inclusive, when the instrument was broken,) as taken from the daily dial readings of the anemometer was 3069 miles, or an average of 5.32 miles per hour. The greatest wind movement for any one day was for the 24 hours ending at 9 A. M. on the 20th, the total being 656 miles, or an average velocity of 27.3 miles per hour. The total movement for this period must have been quite a little greater than that recorded, for it was in the strong wind some time during the preceding night that one cup was broken from the anemometer, after which time the full velocity was not recorded. The least movement was on the 9th, when there was but 8 miles recorded, an average of .3 mile per hour.

December.—There were in this month 21 observations of "calm," upon 15 different dates. There were 35 observations of "light wind," 11 of "fresh wind," 14 of "brisk wind," and 2 of "high wind." The "high wind" occurred on the 10th. The total wind movement for the month was 6,000 miles, by the dial reading of the anemometer. This is an average of 8.06 miles per hour for the whole time. The greatest wind movement was for the 24 hours ending at noon on the 20th, which was 640 miles, or a mean of 23.3 miles per hour for the whole time. The least wind movement was four miles, or .2 mile per hour, on the 26th. Upon three days only was the mean velocity less than one mile per hour.

VELOCITY OF THE WIND

For the 24 hours ending at 9 a. m.

Date.	Total Movement for 24 Hours. Miles.	Average Movement per Hour. Miles.
1889.		
November 1	130	5.4
2	70	3.0
3	104	4.3
4	95	4.0
5	138	5.7
6	146	6.1
7	40	1.7
8	123	5.1
9	8	0.3
10	57	2.4
11	190	8.0
12	96	4.0
13	321	13.4
14	59	2.5
15	26	1.1
16	28	1.2
17	195	8.1
18	255	10.6
19	226	9.4
20	*656	27.3
21		
22		
23		
24		
25		
26		
27	50	2.1
28	20	0.8
29	16	0.7
30	20	0.8
Total for the month†	3069	5.32

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* One cup of the anemometer broke off some time during the night. The total movement of the air was therefore greater than the number given. During the following six days the velocity was not measured.

† Except the six days above noted, during a part of which time there was a high wind, or even greater velocity.

VELOCITY OF THE WIND

For the 24 hours ending at 9 a. m. to the 16th, and ending at 12, noon, for the rest of the month.

Date.	Total Movement for 24 hours. Miles.	Average Movement per hour. Miles.
1889.		
December 1	51	2.1
2	80	3.3
3	297	12.4
4	350	14.6
5	140	5.8
6	41	1.7
7	100	4.2
8	299	12.8
9	523	21.8
10	461	19.2
11	456	19.0
12	90	3.7
13	163	6.8
14	32	1.3
15	11	0.5
*16	114	4.7
17	237	10.0
18	122	5.0
19	300	12.5
20	640	23.3
21	231	9.6
22	311	13.0
23	99	4.1
24	43	1.8
25	7	0.3
26	4	0.2
27	57	2.4
28	134	5.5
29	37	1.5
30	278	11.6
31	292	12.2
Total for the month	6,000	8.06

*The readings were for the 24 hours ending at 9 A. M. until the 16th, and ending at 12, noon, after this date.

CLOUDS.

The state of the weather, or cloudiness, or cloud proportion, as it is variously termed, is indicated in the records on a scale of 0 to 10, the figure designating the portion of sky overcast by clouds. When there are no clouds whatever visible, it is recorded as 0; when one-tenth of the sky is covered by clouds, 1 is used to indicate this state of weather; when the sky is completely obscured by clouds, 10 is recorded as the state of the weather. At the Experiment Station x or xx are also used to indicate that clouds are visible, but not in sufficient amount to cover one-tenth of the sky above the horizon. The table of figures and terms employed are as follows:

x or xx, less than 1-10—clear.
1, 2, 3, 1-10 to 3-10—clear.
4, 5, 6, 7, more than 3-10 to 7-10—fair.
8, 9, 10, more than 7-10 to 10-10—cloudy,
lt. r., when there is a light rain at the time of the observation.
hy. r., when there is a heavy rain at the time of the observation.
lt. s., when there is a light snow at the time of the observation.
hy. s., when there is a heavy snow at the time of the observation.
fog, haze, smoke, according as these are predominant.

OCTOBER.—The prevailing condition of the weather for the month was "fair," and the mean cloud proportion, 4.6, was such as to indicate fair weather, and almost clear. The total number of observations at which the cloudiness was such as to give a record of "clear" weather was 39; of "fair" weather, 27; of "cloudy" weather, 23; of rain, 5. The number of days upon which the cloud proportion was 3 or less, or the clear days, was 11; fair, 13; cloudy, 5; rainy, 2.

NOVEMBER.—The number of observations in November, where the cloudiness was not over 3, was greater than in October, and the mean cloudiness for the month was slightly less, being 4.1, and making the mean condition of the weather "fair," as in October. The prevailing number of days, however (15), were "clear." Number of fair days, 6; cloudy days, 7; rainy days, 2. Number of observations of clear weather, 45; of fair weather, 14; of cloudy weather, 23; of rainy weather, 6; of fog, 2.

DECEMBER.—This was a month of clouds and snow and rain. At but 19 observations was the sky clear; at 16 it was fair weather; at 43 it was cloudy weather; at 7 it was raining, and at 8 it was snowing. The mean condition of the weather was fair, the mean cloudiness being 6.2. The prevailing days were fair, the number being 14. Clear days, 2; cloudy days, 12; rainy or snowy days, 3,

W. S. DEVOL,
Agriculturist and Horticulturist.

METEOROLOGICAL RECORD FOR OCTOBER, 1889.

Nevada Agricultural Experiment Station, Reno, Washoe County, Nevada. Latitude, 39° 31′ 15″ N.; Longitude, 119° 49′ W; Altitude, 4552 feet; 120th Meridian Time.

Day of Month	TEMPERATURE * AND RELATIVE HUMIDITY †						Daily mean temperature. ¼ (7+2+9+9.)*	Daily mean relative humidity. ⅓ (7+2+9.)†	Maximum temperature *	Minimum temperature*
	7 A. M.		2 P. M.		9 P. M.					
	Dry bulb	Relative humidity	Dry bulb	Relative humidity	Dry bulb	Relative humidity				
1	57.7	56.3	76.3	11.9	59.8	23.6	62,40	30.60	76.8	55.7
2	40.1	53.0	79.7	12.0	58.2	17.2	59.27	27.40	81.4	34.0
3	45.9	37.6	78.9	11.8	68.9	12.7	58.82	20.50	83.0	37.4
4	45.9	42.5	84.7	13.3	62.9	37.3	64.10	31.03	88.6	41.2
5	51.4	52.4	89.2	14.2	65.9	23.7	64.00	30.10	85.3	46.0
6	54.7	49.5	72.9	19.8	57.9	42.7	63.35	37.00	85.6	45.8
7	56.8	46.0	51.9	57.5	44.9	62.3	49.62	55.26	67.4	44.0
8	42.5	58.0	48.5	50.5	41.9	62.5	43.70	57.00	50.0	37.6
9	38.7	66.7	59.7	14.8	40.9	62.3	45.05	44.60	53.7	32.0
10	32.9	75.9	56.9	44.5	44.0	54.4	44.48	58.26	52.5	30.0
11	33.9	71.9	63.8	35.0	45.1	56.3	46.67	54.40	63.2	28.4
12	35.2	57.2	68.8	31.8	52.9	39.7	52.45	42.90	68.3	31.2
13	42.0	48.2	64.0	60.0	55.7	42.5	53.48	50.20	64.3	37.1
14	43.7	56.3	61.4	42.8	47.3	64.4	49.92	54.10	64.7	41.0
15	35.7	80.1	59.7	63.2	49.6	49.6	48.65	61.90	66.0	30.3
16	38.4	60.4	67.2	35.2	54.6	45.0	53.70	46.80	69.2	32.0
17	43.1	55.7	65.7	32.6	51.2	55.0	52.80	41.60	66.0	37.0
18	44.4	81.8	57.5	54.3	49.2	62.0	50.07	66.00	59.0	41.9
19	38.7	86.9	58.9	50.7	44.9	56.5	48.85	64.70	59.0	36.0
20	41.8	78.4	58.2	37.6	44.7	86.5	47.35	68.23	59.6	38.3
21	44.5	74.8	52.6	58.8	49.4	65.8	48.75	66.46	54.0	40.7
22	42.7	94.4	47.7	86.0	47.2	76.6	41.20	85.60	53.8	40.9
23	44.7	87.5	53.9	53.7	42.4	82.0	45.85	74.40	56.8	41.8
24	38.1	92.8	59.4	42.2	43.7	75.3	46.22	70.10	59.7	35.4
25	38.0	33.4	57.1	53.5	52.7	72.0	50.12	70.00	57.3	31.3
26	45.0	90.2	61.6	42.2	48.7	68.5	51.00	67.30	63.9	43.6
27	44.7	73.1	59.5	32.7	50.9	54.7	51.25	53.20	56.9	40.4
28	35.9	73.0	45.0	54.6	34.7	73.5	37.57	67.03	50.6	33.5
29	27.8	------	50.4	44.0	42.7	70.5	40.90	--------	52.0	24.3
30	36.7	77.7	45.7	56.1	37.9	77.3	39.55	70.37	57.0	24.0
31	29.3	------	50.0	------	37.7	66.5	38.67	--------	50.0	24.1
Sums	1290.9	1962.9	1896.8	1217.3	1528.4	1738.9	1572.03	1573.04	1971.6	1137.1
Means	41.61	67.69	61.19	40.58	49.30	56.09	50.35	54.24	63.60	36.68

* In degrees Fahrenheit. † Per cent. § Inches.

METEOROLOGICAL RECORD FOR OCTOBER, 1889.

Nevada Agricultural Experiment Station, Reno, Washoe County, Nevada. Latitude, 39° 31' 15" N.; Longitude, 119° 49' W.; Altitude, 4,552 feet; 120th Meridian Time.

Day of Month.	Range of Temperature.*	Daily Mean Barometer †	PRECIPITATION.		WIND.			WEATHER.			
			Total amt. of rain and melted snow.	Average depth of snow, in inches.	Direction from.			Cloud Proportion. Scale, 0-10.			
					7 A. M.	2 P. M.	9 P. M.	7 A M	2 P M	9 P M	Average State. 24 hours.
1	21.1	25.591	0.00	0.00	E	W	NW	7	7	0	Fair
2	47.4	25.585	0.00	0.00	E	SE	NW	xx	7	xx	Clear
3	45.6	25.644	0.00	0.00	Calm	SE	N	8	4	7	Fair
4	43.8	25.586	0.00	0.00	Calm	S	NE	2	xx	0	Clear
5	39.3	25.522	0.00	0.00	Calm	SW	W	xx	5	1	Clear
6	39.8	25.394	0.00	0.00	NW	SW	SW	4	9	3	Fair
7	23.4	25.216	------	0.00	SW	W	SW	5	10	5	Fair
8	12.4	25.416	0.00	0.00	W	W	W	3	9	5	Fair
9	21.7	25.514	0.00	0.00	NE	W	Calm	2	9	xx	Fair
10	22.5	25.511	0.00	0.00	N	Calm	N	5	4	0	Clear
11	34.8	25.579	0.00	0.00	Calm	E	NW	xx	0	0	Clear
12	37.1	25.531	0.00	0.00	Calm	E	NW	0	0	xx	Clear
13	27.2	25.315	0.00	0.00	NE	E	NW	8	9	7	Cloudy
14	23.7	25.450	0.00	0.00	N	N	W	3	2	xx	Clear
15	35.7	25.544	0.00	0.00	Calm	N	N	0	xx	1	Clear
16	37.2	25.516	0.00	0.00	Calm	W	NW	1	7	5	Fair
17	29.0	25.363	0.00	0.00	W	SW	W	9	6	2	Fair
18	17.1	25.460	0.017	0.00	W	Calm	W	9	6	1	Fair
19	23.0	25.418	0.00	0.00	N	S	N	7	10	2	Fair
20	21.3	25.096	0.08	0.00	N	S	SW	9	10	6	Cloudy
21	13.3	25.292	0.087	0.00	N	S	W	5	10	10	Cloudy
22	12.9	25.325	0.065	0.00	SE	S	S	10	10	10	Cloudy
23	15.0	25.455	------	0.00	N	SW	NW	10	4	9	Cloudy
24	24.3	25.572	0.00	0.00	N	S	NW	6	9	0	Fair
25	26.0	25.527	0.00	0.00	Calm	Calm	SW	6	10	10	Cloudy
26	20.3	25.327	0.03	0.00	SW	S	E	4	8	6	Fair
27	16.5	25.432	0.00	0.00	S	W	SW	4	9	9	Cloudy
28	17.1	25.591	0.083	0.00	SW	W	W	1	1	0	Clear
29	27.7	25.484	0.00	0.00	Calm	S	W	8	9	2	Fair
30	33.0	25.577	0.00	0.00	W	N	N	2	6	1	Clear
31	25.9	------	0.00	0.00	Calm	E	N	2	xx	xx	Clear
Sums	834.5	763.833	.362	0.00	------	------	------	140	190	102	
Means	26.92	25.461	.012	0.00	------	------	------	4.5	6.1	3.3	Fair

* In degrees Fahrenheit. † Inches.

METEOROLOGICAL RECORD FOR NOVEMBER, 1889.

Nevada Agricultural Experiment Station, Reno, Washoe County, Nevada. Latitude, 39° 31′ 15″ N.; Longitude, 119° 49′ W.: Altitude, 4,552 feet; 120th Meridian Time.

Day of Month	TEMPERATURE * AND RELATIVE HUMIDITY †						Daily mean temperature. ¼ (7+2+9+9.)*	Daily mean relative humidity. ⅓ (7+2+9.)†	Maximum temperature *	Minimum temperature *
	7 A. M.		2 P. M.		9 P. M.					
	Dry bulb	Relative humidity	Dry bulb	Relative humidity	Dry bulb	Relative humidity				
1	30.2	83.0	54.7	29.2	40.8	76.8	41.62	63.00	56.2	25.7
2	28.7	83.7	62.0	28.8	42.9	72.3	44.12	61.60	62.0	25.6
3	37.8	60.8	50.2	36.6	29.2	49.8	36.60	49.07	49.8	25.1
4	23.9	22.8	86.7	27.5	37.9	56.1	37.60	56.77	50.0	18.0
5	32.1	53.1	52.7	92.4	34.7	62.7	38.55	69.40	51.7	24.3
6	23.7	88.9	56.9	16.4	33.7	67.7	37.00	57.73	56.9	18.8
7	23.9	81.4	59.1	22.9	38.0	67.6	39.75	57.30	58.3	18.9
8	26.5	51.1	51.5	47.5	38.7	62.2	38.85	53.60	60.0	23.1
9	26.9	78.9	63.7	12.8	42.0	70.4	44.00	53.70	65.1	25.4
10	30.7	61.7	57.9	59.1	41.9	77.7	43.10	66.10	59.1	27.8
11	29.9	86.0	52.5	13.2	35.7	60.0	38.45	53.07	51.6	25.9
12	28.7	72.7	59.7	60.0	46.7	75.7	45.45	69.49	61.1	36.1
13	24.5	83.9	49.2	69.4	33.9	77.0	35.37	76.77	49.1	20.1
14	18.7	82.0	54.7	95.8	30.9	73.9	33.80	83.90	53.3	16.1
15	21.9	87.4	51.5	69.0	38.2	42.2	37.45	66.20	56.2	19.5
16	22.5	72.3	58.3	21.5	40.7	45.5	40.55	46.43	60.8	19.5
17	38.7	57.7	52.0	58.2	54.9	27.2	50.12	47.36	60.3	33.7
18	37.7	96.0	40.7	86.4	33.7	95.0	36.45	92.46	47.1	31.5
19	34.0	74.2	40.0	89.6	44.7	80.1	40.85	81.30	48.0	29.5
20	43.2	75.4	49.0	61.8	47.4	64.4	46.75	67.20	50.3	41.2
21	47.7	69.0	50.9	80.9	51.8	57.4	50.55	69.06	57.4	41.1
22	51.7	77.7	42.0	90.6	40.7	82.4	43.77	84.56	58.5	38.9
23	33.2	62.3	43.7	29.3	35.9	68.1	37.17	52.52	44.4	31.4
24	28.7	92.6	44.0	59.0	29.7	87.0	33.02	79.50	46.1	27.1
25	25.9	89.7	50.9	69.3	34.7	81.7	36.35	80.07	51.0	24.0
26	28.7	91.4	53.7	64.9	39.4	74.6	40.30	76.97	58.0	27.7
27	27.9	89.0	51.4	44.8	36.7	85.1	38.17	72.97	52.3	27.3
28	26.3	84.7	51.3	80.2	38.7	62.7	38.75	75.87	51.0	25.7
29	27.7	89.9	38.7	85.1	36.9	96.0	35.05	90.33	42.7	26.5
30	33.7	100.0	38.0	100.0	35.5	100.0	35.67	100.00	38.7	31.5
Sums	915.7	2362.6	1531.6	1767.6	1166.6	2098.3	1192.62	2054.32	1607.0	807.0
Means	30.52	78.75	510.5	58.92	38.89	69.94	39.75	68.48	53.57	26.90

* Degrees, Fahrenheit. † Per cent.

METEOROLOGICAL RECORD FOR NOVEMBER, 1889.

Nevada Agricultural Experiment Station, Reno, Washoe County, Nevada. Latitude, 39° 31′ 15″ W.; Longitude, 119° 49′ W.; Altitude, 4,552 feet; 120th Meridian Time

Day of Month	Range of Temperature*	Mean Barometer§	PRECIPITATION.		WIND. Direction from.			WEATHER. Cloud Proportion. Scale, 0-10.			
			Total amt. of rain and melted snow	Average depth of snow, in inches	7 A. M.	2 P. M.	9 P. M.	7 AM	2 PM	9 PM	Average State. 24 hours.
1	30.5	25.816	0.00	0.00	Calm	E	N	0	xx	0	Clear
2	36.4	25.710	0.00	0.00	Calm	E	W	0	xx	0	Clear
3	24.7	25.739	0.00	0.00	Calm	SE	W	0	xx	0	Clear
4	32.0	25.653	0.00	0.00	Calm	SE	Calm	xx	xx	xx	Clear
5	27.4	25.670	0.00	0.00	NE	NE	N	0	0	0	Clear
6	38.1	25.698	0.00	0.00	Calm	S	W	0	xx	xx	Clear
7	39.4	25.678	0.00	0.00	Calm	SE	NW	0	xx	xx	Clear
8	36.9	25.704	0.00	0.00	Calm	E	Calm	8	1	8	Fair
9	39.7	25.703	0.00	0.00	NW	SE	NW	3	1	xx	Clear
10	31.3	25.580	0.00	0.00	NE	N	S	9	6	4	Fair
11	25.7	25.588	0.00	0.00	NE	E	N	0	xx	0	Clear
12	25.0	25.429	0.00	0.00	W	W	NW	8	xx	0	Clear
13	29.0	25.582	0.00	0.00	NW	SE	N	1	0	0	Clear
14	37.2	25.616	0.00	0.00	W	NE	Calm	6	2	0	Clear
15	36.7	25.627	0.00	0.00	Calm	S	N	0	0	0	Clear
16	41.3	25.512	0.00	0.00	E	SE	W	xx	0	2	Clear
17	26.6	25.425	0.00	0.00	N	S	W	8	8	8	Cloudy
18	15.6	25.265	0.735	0.00	NE	SW	W	10	10	10	Rainy
19	18.5	25.287	0.395	0.50	NE	W	SW	6	10	10	Cloudy
20	9.1	25.431	0.050	0.00	W	W	W	10	9	8	Cloudy
21	16.3	25.462	0.00	0.00	W	SW	SW	5	5	5	Fair
22	19.6	25.262	0.355	0.00	NW	W	N	4	8	10	Cloudy
23	13.0	25.417	0.00	0.00	NW	W	N	7	10	9	Cloudy
24	19.0	25.543	0.00	0.00	W	SE	W	9	xx	0	Clear
25	27.0	25.630	0.00	0.00	NE	W	NW	5	7	2	Fair
26	30.3	25.594	0.00	0.00	Calm	SE	N	4	7	8	Fair
27	25.0	25.456	0.00	0.00	Calm	E	W	10	6	2	Fair
28	25.3	25.496	0.00	0.00	Calm	Calm	N	9	8	9	Cloudy
29	16.2	25.495	T	0.00	NE	Calm	Calm	8	10	10	Cloudy
30	7.2	25.390	0.200	0.00	Calm	E	W	10	9	10	Cloudy
Sums	800.0	766.442	1.735	0.50				140	117	115	
Means	26.67	25.548	0.058	0.017	NE	SE	W	4.7	3.9	3.8	Fair

*Degrees Fahrenheit. §Inches. xx Less than 1.

METEOROLOGICAL RECORD FOR DECEMBER, 1889.

Nevada Agricultural Experiment Station, Reno, Washoe County, Nevada. Latitude, 39° 31' 15" N.; Longitude, 119° 49' W.; Altitude, 4,552 feet; 120th Miridian Time.

Day of Month	TEMPERATURE * AND RELATIVE HUMIDITY †						Daily mean temperature. ¼ (7+2+9+9.)*	Daily mean relative humidity. ⅓ (7+2+9)†	Maximum temperature *	Minimum temperature *
	7 A. M.		2 P. M.		9 P. M.					
	Dry bulb	Relative humidity	Dry bulb	Relative humidity	Dry bulb	Relative humidity				
1	36.0	100.0	40.8	88.8	42.5	82.1	40.75	60.30	42.2	34.3
2	41.5	64.5	------	------	38.7	80.6	44.15	------	51.8	36.5
3	44.7	59.4	43.8	73.6	38.9	79.8	43.05	70.93	51.5	37.9
4	33.2	76.2	40.2	51.8	33.9	70.9	37.10	66.30	48.0	36.5
5	27.7	94.7	40.0	71.6	36.0	83.9	35.87	86.43	44.1	25.0
6	22.8	89.4	34.8	95.3	33.7	88.0	31.83	91.23	37.7	22.0
7	28.5	84.2	34.5	65.1	33.9	73.0	33.75	74.10	41.8	25.6
8	40.9	64.0	37.5	94.4	37.2	87.0	38.37	81.80	42.9	30.8
9	34.9	91.0	42.0	90.4	39.7	88.0	39.07	89.80	43.9	32.2
10	46.7	75.7	48.5	58.4	35.8	95.0	41.70	76.36	51.0	31.3
11	34.5	87.5	37.7	81.1	35.7	84.0	35.90	84.20	40.2	33.0
12	34.7	91.0	39.2	81.6	33.7	82.0	35.32	89.86	40.2	30.1
13	28.9	90.2	33.0	90.0	29.2	89.0	30.42	89.73	35.5	28.3
14	24.7	87.7	27.7	90.7	28.7	95.0	27.45	91.13	29.0	23.0
15	27.8	89.0	37.9	34.4	35.7	92.5	36.77	71.96	38.1	23.5
16	29.5	86.0	31.7	82.7	24.2	91.2	27.40	86.63	37.2	28.8
17	32.7	85.0	38.5	44.1	27.5	89.0	31.75	72.70	44.9	23.4
18	24.7	88.4	35.7	62.0	32.7	71.7	33.95	74.03	37.7	18.8
19	31.9	78.9	41.0	74.4	40.0	74.4	38.22	75.90	44.8	22.9
20	36.7	52.7	37.9	49.7	31.9	66.9	34.85	56.10	42.0	28.5
21	26.1	79.7	32.8	91.0	27.3	63.7	28.37	78.13	41.9	23.4
22	26.7	91.6	30.9	89.9	27.5	94.5	28.15	92.00	35.0	15.0
23	23.5	100.0	29.7	95.0	31.7	95.0	29.10	96.66	32.1	23.6
24	24.7	100.0	29.7	100.0	27.3	87.8	27.45	95.93	31.7	15.5
25	27.7	94.7	34.0	87.0	29.9	95.0	30.37	92.23	35.3	25.3
26	26.0	68.6	30.1	91.4	27.7	94.7	27.87	86.90	30.8	24.8
27	22.7	86.7	28.5	68.5	24.7	75.7	25.15	76.96	28.9	17.7
28	29.1	80.6	------	------	10.0	68.0	16.30	------	29.1	3.5
29	—3.8	59.2	14.5	79.5	12.0	85.0	8.67	74.57	15.0	—7.3
30	33.4	78.8	35.4	77.2	26.4	74.4	30.40	76.80	37.3	9.3
31	24.0	83.4	32.0	88.0	30.8	77.8	31.15	83.06	35.2	12.2
Sums	903.1	2558.8	1041.6	2247.6	964.9	2579.7	991.69	2351.61	1195.8	735.4
Means	29.77	82.54	35.92	77.50	31.13	32.22	31.99	81.09	38.54	23.75

* Degrees, Fahrenheit. † Per cent.

METEOROLOGICAL RECORD FOR DECEMBER, 1889.

Nevada Agricultural Experiment Station, Reno, Washoe County, Nevada. Latitude, 39° 31′ 15″ N: Longitude, 119° 49′ W.; Altitude, 4,552 feet; 120th Meridian Time.

Day of Month	Range of Temperature*	Mean Barometer§	PRECIPITATION.		WIND.			WEATHER.			
					Direction from.			Cloud Proportion. Scale, 0-10.			
			Total amt. of rain and melted snow	Average depth of snow, in inches	7 A. M.	2 P. M.	9 P. M.	7 AM	2 PM	9 PM	Average State. 24 hours.
1	7.9	25.232	0.48	0.00	E	W	S	10	10	10	Rainy
2	15.3		0.02	0.00	NE	W	W	4	3	2	Clear
3	13.6	25.292	xx	0.00	W	W	W	3	7	8	Fair
4	11.5	25.282	0.00	0.00	NW	S	W	5	2	6	Fair
5	19.1	25.321	0.00	0.00	Calm	S	N	9	9	3	Fair
6	15.7	25.247	0.02	xx	SW	Calm	W	2	10	3	Fair
7	16.2	25.301	0.04	0.60	Calm	W	NW	5	2	9	Fair
8	12.1	25.205	0.07	0.00	S	S	W	9	9	5	Cloudy
9	10.7	25.385	0.00	0.00	NW	W	E	9	10	8	Cloudy
10	19.7	25.162	0.015	0.00	S	N	S	8	8	9	Cloudy
11	7.2	25.179	0.19	0.00	W	SE	W	5	8	9	Cloudy
12	10.1	25.244	0.15	xx	NE	W	Calm	9	6	6	Fair
13	7.2	25.428	0.27	2.10	Calm	E	N	10	9	7	Snowy
14	6.0	25.471	0.00	0.00	W	SE	Calm	10	10	9	Cloudy
15	14.6	25.518	0.03	0.02	Calm	W	Calm	9	7	10	Cloudy
16	8.4	25.477	0.00	0.00	W	E	Calm	10	7	xx	Fair
17	21.5	25.332	0.00	0.00	S	NW	NE	5	1	xx	Clear
18	18.9	25.302	xx	xx	Calm	SE	W	10	9	1	Fair
19	11.9	25.338	0.05	xx	W	W	W	9	9	4	Cloudy
20	13.5	25.408	0.03	0.00	W	W	W	10	1	0	Fair
21	18.5	25.124	0.18	2.50	N	S	W	10	10	xx	Fair
22	20.0	25.106		0.80	SW	SW	N	2	10	10	Cloudy
23	8.5	25.073	0.33	6.00	N	NE	NE	9	8	xx	Fair
24	16.2	25.191	0.35	9.00	Calm	Calm	Calm	10	10	10	Snowy
25	10.0	25.415	0.08	3.00	Calm	Calm	Calm	10	9	8	Cloudy
26	6.0	25.552	T	T	Calm	NE	N	10	10	10	Cloudy
27	11.2	25.425	0.00	0.00	NW	Calm	W	9	10	9	Cloudy
28	25.6		xx	T	N	N	Calm	10	2	xx	Fair
29	22.3	25.691	0.00	0.00	Calm	Calm	NE	8	8	9	Cloudy
30	28.0	25.316	T	0.50	SW	W	W	8	4	8	Fair
31	23.0	25.246	0.00	0.00	W	W	W	9	5	5	Fair
Sums	450.2	734.483	2.305	24.52				246	223	180	
Means	14.52	25.327	0.074	0.79	W	W	W	7.9	7.2	5.8	Fair

* Degrees Fahrenheit. § Inches. xx, Less than 1.

METEOROLOGICAL SUMMARY.

October, November and December, 1889, compared with the same months of 1888, Nevada Agricultural Experiment Station.

		OCTOBER.		NOVEMBER.		DECEMBER.	
		1888.	1889.	1888.	1889.	1888.	1889.
Air pressure. Readings corrected for temperature.	Highest barometer, inches		25.751	25.730	25.864	25.736	25.741
	Date		31st	8th	1st	3d	29th
	Lowest barometer, inches		25.045	25.201	25.159	25.041	25.031
	Date		20th	16th	18th	22d	21st
	Range of barometer, in.		.706	.529	.705	.695	.710
	Mean barometer, inches		25.462	25.472	25.548	25.461	25.327
Temperature (Fahrenheit)	Highest, degrees	82.9	85.6	69.1	65.1	59.7	51.8
	Date	11th	6th	2d	9th	8th	2d
	Lowest, degrees	27.3	24.0	17.0	16.1	22.4	-7.3
	Date	22d	30th	29th	14th	19th	29th
	Monthly range, degrees	55.6	61.6	52.1	49.0	37.3	59.1
	Mean maximum, degrees	68.86	63.60	51.36	53.57	46.75	38.54
	Mean minimum, degrees	37.41	36.68	29.00	26.90	28.65	23.75
	Greatest daily range, degrees	43.8	47.4	40.4	41.3	36.1	28.0
	Date	11th	2d	2d	16th	8th	30th
	Least daily range, degrees	14.8	12.4	8.4	7.2	3.6	6.0
	Date	24th	8th	16th	30th	31st	14th & 26th
	Mean daily range, degrees	31.45	26.92	22.36	26.67	18.10	14.52
	Mean—¼ (7+2+9+9), degrees	53.83	50.35	40.18	39.75	37.70	31.99
Mean relative humidity, per cent.		43.90	54.24	61.48	68.48	65.15	81.09
Mean dew point, degrees F.		29.13	32.50	27.77	29.22	24.93	26.64
Total precipitation, inches		Trace	0.012	1.950	1.735	0.700	2.305
Total snowfall, inches		0.00	0.00	0.00	0.5	1.62	24.52
Frost, number of times observed		17	7		1		1
Thunder storms, number of		0	0	0	0	0	0
Weather.	Rainy (or snowy) days	0	2	7	2	9	3
	Cloudy days	0	5	7	7	9	12
	Fair days	5	13	6	6	12	14
	Clear days	26	11	17	15	10	2
	Prevailing	Clear	Fair	Clear	Clear	Fair	Fair
Wind, times observed blowing from.	North	11	16	4	10	3	9
	Northeast	8	3	12	9	13	7
	East	21	7	12	7	14	4
	Southeast	3	3	2	8	8	5
	South	3	10	1	4	3	7
	Southwest	14	11	13	4	11	4
	West	22	19	17	23	30	31
	Northwest	8	10	18	7	11	5
Times of calm		3	14	1	18	0	21

DIRECTION OF WIND,

October, November and December, 1889, as observed at the Nevada Agricultural Experiment Station.

	TIMES OBSERVED BLOWING FROM.								Times Calm.	Prevailing.
	N.	NE.	E.	SE.	S.	SW.	W.	NW.		
October.										
7 A. M.	7	2	2	1	1	2	4	2	10	N.
2 P. M.	3	0	4	2	8	4	7	0	3	S.
9 P. M.	6	1	1	0	1	5	8	8	1	W & NW
Total	16	3	7	3	10	11	19	10	14	W.
November.										
7 A. M.	1	7	1	0	0	0	6	3	12	W.
2 P. M.	1	2	6	8	3	2	6	0	2	SE.
9 P. M.	8	0	0	0	1	2	11	4	4	W.
Total	10	9	7	8	4	4	23	7	18	W.
December.										
7 A. M.	3	2	1	0	3	3	7	3	9	W.
2 P. M.	2	2	2	3	4	1	11	1	5	W.
9 P. M.	4	3	1	2	0	0	13	1	7	W.
Total	9	7	4	5	7	4	31	5	21	W.
Total 3 mos. ending Dec. 31,'89	35	19	18	16	21	19	73	22	53	W.

TEMPERATURE SUMMARY.

October, November and December, 1889.

	Degrees, Fahrenheit.	Date.
October.		
Highest maximum	85.6	6th
Lowest maximum	50.0	8th and 31st
Mean maximum	63.60	
Highest minimum	55.7	1st
Lowest minimum	24.0	30th
Mean minimum	36.68	
Warmest day	64.10	4th
Coldest day	37.57	28th
Greatest daily range	47.4	2d
Least daily range	12.4	8th
Mean daily range	28.23	
Monthly range	61.6	
Monthly mean	50.35	
November.		
Highest maximum	65.1	9th
Lowest maximum	38.7	31st
Mean maximum	53.57	
Highest minimum	41.2	20th
Lowest minimum	16.1	14th
Mean minimum	26.9	
Warmest day	50.55	21st
Coldest day	33.02	24th
Greatest daily range	41.3	16th
Least daily range	7.2	30th
Mean daily range	22.36	
Monthly range	49.0	
Monthly mean	39.75	
December.		
Highest maximum	51.8	2d
Lowest maximum	15.0	29th
Mean maximum	38.54	
Highest minimum	37.9	3d
Lowest minimum	—7.3	29th
Mean minimum	23.75	
Greatest daily range	28.0	30th
Least daily range	6.0	14th and 26th
Mean daily range	14.52	
Monthly range	59.1	
Monthly mean	31.99	
For the quarter.		
Highest maximum	85.6	Oct. 6th
Lowest maximum	15.0	Dec. 29th
Mean maximum	51.90	
Highest minimum	55.7	Oct. 1st
Lowest minimum	—7.3	Dec. 29th
Mean minimum	29.13	
Warmest day	64.10	Oct. 4th
Coldest day	8.67	Dec. 29th
Greatest daily range	47.4	Oct. 2d
Least daily range	6.0	Dec. 14 & 26th
Mean daily range	22.66	
Quarterly range	92.9	
Quarterly mean	40.63	

NEVADA

Agricultural * Experiment * Station,

RENO, NEVADA.

The State Legislature, in accepting the National appropriation for an Agricultural Experiment Station, located the Station at the Nevada State University at Reno. **The Station is now** well equipped, and is making a study of the many perplexing **questions constantly** presenting themselves to the farmers, gardeners and herdsmen of **Nevada**. These investigations will be pursued with a view to the solution **of some** of these questions, and the publication of the results, in the hope that the **efforts put forth** here may be of service in the development of the agricultural resources of **our** State and the advancement of the agricultural interests.

Investigations are in progress respecting: (1) The growth of the various farm **crops**; (2) The growth, treatment and food value of various forage plants and their **adaptability** to our soil and climate; (3) The best varieties and most satisfactory **method** of growing garden vegetables; (4) The adaptability and treatment of large **and small** fruits; (5) The structure, nature and distribution of native and introduced **plant**; (6) The purity and vitality of seeds; (7) The chemical composition of **feeding** stuffs, soils, fertilizers and potable waters; (8) The insects of the State and **the use** of insecticides and insecticide apparatus; (9) Forest trees and their care; (10) **The** diseases of plants and of animals; (11) Meteorology and soil temperature. **It is** proposed to extend the work into other fields.

Any citizen of Nevada, who is interested in agriculture in any of its departments, is invited to apply to the Station for any information that he may desire concerning the theory and practice of any branch of Agriculture. All such communnications will receive due consideration, and, as far as possible, will be answered **promptly**.

Citizens of the State are invited to suggest to the Station such lines of investigation as they most desire undertaken. All suggestions of this nature will receive **attention** at the hands of the Station Staff, and will be acted upon so far as the means **at our command** will permit.

The Station desires for study and for museum purposes samples of plants, seeds, **farm** crops, sections of trees, minerals, soils, abnormally developed plants and **animals, etc.** For any of these we will be grateful.

All communications, specimens and express packages should be addressed,

DIRECTOR EXPERIMENT STATION,
Reno, Washoe County, Nevada.

BULLETINS

Of the Nevada Agricultural Experiment Station are issued quarterly, or oftener. These will be sent free to all who apply for them, so long as the supply lasts. Inquiries by those interested in the work of the Station will be replied to as promptly and fully as possible.

All communications should be addressed,

DIRECTOR EXPERIMENT STATION,
Reno, Washoe County, Nevada.

BULLETIN No. 8.

NEVADA

Agricultural * Experiment * Station.

JANUARY, 1890.

Department of Entomology,

BY

F. H. HILLMAN.

THE CODLING MOTH.

ITS LIFE, HISTORY AND REMEDIES FOR ITS EXTERMINATION.

IN view of the fact that the codling moth is practically making its first appearance in Nevada, it is deemed important that its character, accompanied by a description of the means employed in destroying it, should be laid before the fruit growers of the State.

This subject has been very thoroughly treated by entomologists at several of the Eastern Agricultural Experimental Stations, and to them is due the credit of placing before the people the best methods of destroying this serious pest. It is hoped that the attention of the fruit growers of Nevada will be drawn to this insect, which shall result in timely and united action against its ravages.

HISTORY.

According to Treat, the codling moth was imported from Europe early in the present century. Its spread to the Western States has been gradual, reaching Iowa within the past twelve years. Mathew Cooke says that it was introduced to California in 1873, at Sacramento, where had been received a shipment of apples from the East for exhibition at the State Fair. The same author states that the insect's first appearance was in the Spring of 1874, when it was found in an orchard near Sacramento. Since that date it has spread rapidly, and is said to be found in thirty-four counties of California at the present time.

ZOOLOGICAL POSITION OF THE CODLING MOTH.

ERRATA.

PAGE 1.—*For* "Its Life, History and Remedies for Its Extermination," *read* Its Life-History and Remedies for Its Extermination; *for* "*Tortricidæ*," *read Tortricidæ.*

PAGE 2.—*For* "its interior angles," *read* the interior angles. Fig. 1 is twice the size of the moth.

PAGE 3.—For "Fig. 2," see back cover; *in* "and thus preventing," etc., *omit* and; *for* "Board of Horticulture and Agriculture Commissioners of Colorado," *read* Board of Horticultural and Agricultural Commissioners of California; *for* "120 gals. to 180 gals. of water," *read* 120 gals. or 180 gals. of water.

PAGE 4.—*For* "fairly divided," *read* finely divided.

PAGE 9.—Figs. 4 and 5 represent Figs. 2 and 3 in use.

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one egg is laid on the same apple by the same female, and the instinct of the female causes her to pass by an egg bearing apple in her search for an unoccupied field for her progeny's depredations. It has been determined that from 200 to 300 eggs may be laid by a single female.

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ZOOLOGICAL POSITION OF THE CODLING MOTH.

The codling moth belongs to the order *Lepidoptera*, to which belong all butterflies and moths, or insects having scale bearing wings. It is included in the family *Tortricidæ*, and is technically known as *Carpocapsa pomonella*.

THELIFE HISTORY OF THE CODLING MOTH,

Like that of all insects of this order, consists of four stages of existence—viz.: the *egg*, the *larva*, or worm-like form, the *pupa*, or resting stage, and the *imago*, or mature insect.

THE EGG

Is laid by the imago at some rough place upon the apple's surface. The laying of the first eggs takes place about the time the petals of the apple blossoms are falling. At this time the apple is very small, and the blossom end usually projects upward. The drying sepals, stamens and stigmas present the roughest and most convenient position for the deposition of the egg, and thus this is usually selected for this purpose by the moth. It will be seen that this is most true in the case of the first brood. At the time of egg laying for the second brood, the apple has attained a greater size; its weight often causes it to bend downward, practically hiding the blossom end, while the stem end projects upward, the tender stem bent to one side, thus presenting a decided depression in the apple's surface, which is now selected by the moth as she deposits her egg. While this is not always true, it is very frequently so in the cases of the second and third broods. The egg is sometimes deposited upon the surface of the apple at some point other than the above mentioned.

The egg is of minute size and of a yellowish color. It is rarely that more than one egg is laid on the same apple by the same female, and the instinct of the female causes her to pass by an egg bearing apple in her search for an unoccupied field for her progeny's depredations. It has been determined that from 200 to 300 eggs may be laid by a single female.

THE LARVA

Hatches from the egg in from seven to ten days and at once begins actively to gnaw towards the apple's core. It is at this time microscopic in size. In six days, according to Mathew Cooke, it attains a length of one-quarter inch and about the diameter of a fine silk thread. About twelve days are required by the larva to attain its growth. During this time it has undergone four or five moults, the cast skins usually being devoured by the larva. It has in this time eaten its way from the point of entrance to the core, about which it has burrowed, rendering unfit for use the greater portion of the fruit. The larva retains its yellowish white color until it attains its growth. At this time its body bears a few hairs. The head and anterior portion of the first segment of the body are black or dark brown. The length of the mature larva is from one-half to three-fourths of an inch. The presence of the larva may be detected by the brown feces usually found at the blossom end of the apple. A hole is sometimes found at the side of the apple through which the feces pass and the larva escapes. On leaving the apple the larva seeks some protecting crevise in which to pass the pupa state. This is generally found under the tree's rough bark, crotches of limbs, under chips of wood, or even in the ground, if this be not too hard. Frequently the injured apple falls to the ground before the insect makes its escape, upon which it usually makes its way to the trunk of the tree. If the apple has not fallen the larva either makes its way along the apple bearing twig to the larger limbs or trunk or lowers itself to the ground by a silken thread which it spins, and then proceeds as in the case of the fallen apple to reach the tree's trunk. Finding some sheltered crevice, as between a rough scale and the bark of the tree, it spins a silken cocoon about it and enters the third stage, that of

THE PUPA, OR CHRYSALIS.

The duration of this stage differs greatly in the different broods. In the first and intermediate broods two or three weeks elapse before the escape of the imago. The last brood usually passes the winter in this stage, and thus the mature moth does not come forth till the following spring. Thus it is that this last brood becomes the great disseminating agent through which this pest has become widespread. Apples containing larvæ of the last brood of insects are packed for storage or shipment. The larvæ leave the fruit and find their place of concealment between the staves or under the hoops of the packing barrel; if in boxes, between adjacent boards, or in its interior angles. If the cases remain for long in a storeroom the larvæ may venture farther and secrete themselves in the floor or walls of the room. It is in stocking these shipping cases that this insect becomes most dangerous in this form. They are thus transported to distant points and allowed to come forth in localities in which they have hitherto been unknown. It is to this cause without doubt that the pest's presence in Nevada is due. Experience has shown that it is very important that fruit cases should be new, or if second hand, they should be thoroughly disinfected. The cocoon of the chrysalis ranges from one-half to five-eighths of an inch in length and is of a light color. Those of the last brood have a cement intermingled with the silken fibres which serves as a protection from rain. This stage completed, the insect undergoes its last transformation and appears as

THE IMAGO, OR MATURE MOTH.

This is truly a beautiful insect, represented in Fig. 1. When the wings are

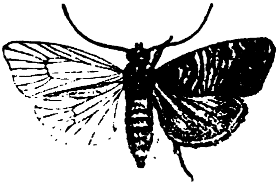


Fig. 1.

expanded the body is about five-sixteenths inch long, with wing expansion of eleven-sixteenths inch. The general color is brown, the anterior wings having much grey with transverse darker stripes. A marked characteristic is the copper colored spot at inner angle of the anterior wing. The color of the posterior wings varies from a dark brown at the margins to a much lighter shade at their attachments to the body. The color of the head and throat is dark grey. The abdomen has alternating transverse stripes of dark and light brown.

REMEDIES.

Various means for the codling moth's destruction are tried, some of which are attended by marked success. As the moth flies mostly by night, and is attracted by light, its capture has been attempted by placing among the apple trees lamps surrounded by pans of sweetened water, as shown in Fig 2. A few are caught in this way, but not enough to materially decrease their number. Some trying this method have thought themselves very successful, but this was due to their inability to distinguish the codling moth from the many of other species which they caught. Their destruction while in the pupa state has been attended by considerable success. If trees infested by the moth have much rough bark a great proportion of the pupæ of the following brood will be found beneath this in the fall or during winter. By carefully removing and burning this rough bark these pupæ will be destroyed. A common hoe having a short handle serves very well for this purpose. It will be seen that as not all the insects will be destroyed by this method, many will escape; it will also be noted that it is not before, but after the depredations of this brood, that the capture is made. The disinfection of apple boxes or barrels having been previously used destroys the insects in the pupa stage, and thus preventing the transportation of the pests to new localities. It was recommended by the chief officer of the Board of Horticulture and Agriculture Commissioners of Colorado that all fruit packages to be used a second time should be disinfected by dipping the packages and allowing them to remain not less than two minutes in boiling water containing not less than one pound of commercial potash or three-quarters pound common lye to every twenty gallons of water.

The most effectual remedies are applied while the insect is in the larvæ state. One method very generally employed is that of banding the tree, by placing about the trunk, half way between the ground and the limbs, a band of cloth so fastened as to permit the larvæ to get between it and the bark, but not so loose as to allow them to pass by it. The cloth may be removed at intervals of a few days, and the larvæ found destroyed in any way found most convenient. A great proportion of the pests—though not all of them—may be destroyed by this means. It will be noted, however, that it is not until *after* the "worms" have injured and left the fruit of the season, that their capture is made. This fact, with that of the incomplete success of the method, leaves room for marked improvement, which is found in

ARSENICAL POISONING.

This is the application of Paris green or London purple in water mixture, by spraying upon the trees. These are compounds of arsenic, of which Paris green is somewhat the stronger. Either of these is practically insoluble in water, and for this reason is much safer to use than pure arsenic, which is soluble in water to a certain extent. The insolubility of Paris green and London purple demands that they be thoroughly mixed with the water used in spraying. This mixture must be kept uniform during the entire process of application. The fact of the insolubility of these compounds permits them to remain on the *outside* of the fruit treated, and thus become washed or shaken off. Pure arsenic, being much more soluble, is, by osmosis, taken into the tissue of leaves and fruit, and thus remains a source of injury to the foliage, and to the consumer of the fruit.

Experiment has shown that 1 lb. of London purple to 100 gals. or 150 gals. of water, or 1 lb. of Paris green to 120 gals. to 180 gals. of water, forms a mixture of proper strength for treatment of the codling moth. The application of this requires a force pump capable of throwing a forcible stream, and a nozzle that will make a fine spray of this stream, without destroying its force. In order that the greatest efficiency be obtained in the use of this remedy, it is of first importance that the poisoned liquid shall be applied in as forcible manner as possible, that it may reach every part of the surfaces of all the apples.

The time for application is governed at first by the advancement of the fruit. The first application should be made when most of the petals of the blossoms have fallen. If applied earlier than this, honey bees gathering nectar from the blossom will be killed; and, if later than this, it is very likely that the first eggs have hatched, and the larvæ so far within the apples as to be safe from harm.

It will be seen that it is not necessary that the eggs be hatched before the application of the poison; for this, being applied at the above mentioned time, finds the young larvæ just hatched, in which case it is acted upon immediately; or, if the egg is not hatched, the poison remains fairly divided, and, if thoroughly applied, evenly distributed over the apple's surface, in the majority of cases. This explains the necessity of having a forcible but finely divided spray at the time of application.

As the egg laying moths are not in the least affected by this treatment, and so continue the laying of eggs, it is necessary that a second and even a third application be made to insure the best results. In case no heavy rains have washed off a part of the first applied poison, a more dilute mixture (1 lb. to 150 or 200 gals.), in case of London purple, may be used; or, if Paris green is used, a proportionally larger portion of water should be taken. This is necessary to protect the foliage, which, in the case of apples, is gravely injured by too active application of arsenical poison. The second application may be made seven or ten days later than the first; and if a third application is made at all, it may follow the second by ten or fourteen days.

The following table, showing the effect of different numbers of applications, is taken from the annual report of the Michigan Agricultural Experiment Station for 1888:

		Per cent. Wormy, July 31.	Per cent. Wormy, Aug. 31.	Effect on Foliage.
Sprayed once	No. 1	10	14	No injury
	No. 2	4	16	No injury
Sprayed twice, June 6th and 12th	No. 1	3½	2	Slight injury
	No. 2	9	6	Slight injury
Sprayed thrice, June 6th, 12th and 20th	No. 1	3	5	Serious injury
	No. 2	2	7	Some injury
Not sprayed	No. 1		50	
	No. 2		28	

In regard to possible dangers in the use of these poisons, I would say that many questions, including the following, have been satisfactorily answered.

INJURY TO FRUIT.

Are apples thus treated rendered dangerous for consumption? On considering the dilute condition of the mixture and the small amount of surface presented by the young apple, it will be seen that a very small amount of the poison at the most is left adhering to the apple. When it is remembered also that the rough, fuzzy skin of the young apple which catches and holds the poison is exchanged long before the apple ripens for the smooth, glossy surface of the mature fruit, and that during the months of growth the rains and winds have given their aid, it seems hardly probable that a dangerous amount of poison remains. Experience and chemical analysis have proved this to be true, and I believe not a case is on record of poisoning from fruit thus treated.

INJURY TO FOLIAGE.

It has been found that an excessive use of arsenical poison is injurious to foliage;

so much so, in fact, as to completely defoliate the trees, if the application of the poison is not made judiciously. To guard against this injury to the foliage it must be borne in mind that the second and third applications must be made with more dilute mixtures than the first. Here the value of the fine spray is again shown. It permits a *less quantity* of the liquid to be distributed *evenly* over the foliage, and not to stand in large drops, which, upon evaporation, leave the poison in large quantities, in spots.

The condition of the atmosphere, at and for a few days after spraying, greatly influences the effect of the poison on the foliage. Experiment has proved that a rain, or damp weather following the application of arsenical poison, causes the foliage to be injured far more than it is if the atmosphere remains dry. This is probably due to the fact that the arsenic, being slightly soluble in water, goes into solution to a certain extent, and thus, by osmosis, enters the tissue of the leaf, destroying it. This is impossible if the poison remains dry.

DANGER TO HONEY BEES.

Honey bees are attracted in great numbers by the apple blossoms. They reach with their tongues into the blossoms for the nectar, and are almost sure to be fatally poisoned, if the spraying for the codling moth is done before most of the petals are fallen. As no advantage over the codling larvæ is gained by spraying before this time, its hould be borne in mind that doing so deals a death blow to honey bees.

GRAZING ANIMALS.

Lastly, Whether grass beneath poison treated trees is not dangerous for grazing animals, has been frequently asked and satisfactorially answered. I shall call the reader's attention to the manner in which this question was answered at the Michigan Experiment Station, where I took part personally in the work of the following experiments:

A tree, under which was a thick growth of timothy and clover, was thoroughly sprayed with a strong mixture of London purple. After the drippings (the amount of which was increased by a strong wind blowing at the time) had ceased to fall from the leaves, the grass was carefully cut and fed to a horse. Though this was repeated, the poison had no effect upon the animal.

In a second experiment the entire drippings from a tree most thoroughly sprayed were caught, and the amount of poison determined by chemical analysis. This was found to be four-tenths (.4) of a grain. Again, to make a decidedly practical test, three sheep were placed in a pen about a tree which was thoroughly sprayed with an unusually strong mixture of London purple. The grass beneath this tree was all eaten—not trodden down. The sheep were moved from tree to tree, which in each case was thoroughly sprayed. For nearly two weeks this was continued, the sheep eating the grass in each case. At the end of this time the animals were returned to their owner none the worse for their experience. The sheep is very susceptible to the action of arsenical poison, more so than the horse or cow. The result of the above experiments seems sufficient to prove that domestic animals are safe from all danger of this kind.

THE CODLING MOTH IN NEVADA.

In order to learn the amount of damage the codling moth is doing in Nevada, the following questions were submitted to many of the fruit growers of the State:

1. *Are your apples at all "wormy?"*
2. *If so, about what per cent. of the whole?*
3. *How many years have your apples been injured?*
4. *What preventives for this insect have you tried?*
5. *What success has attended your trials of preventives?*

A great variety of answers were received from different portions of the State. Many localities seem to be free from the moth, while in other parts from 50 per cent. to 75 per cent., and in one case 90 per cent. of the fruit is reported injured this year. The longest period of injury given is eight years; the average period is but two and one-half years. It is a noticeable fact that 63 per cent. of the orchards suffering the greatest injury have been affected *only one year*. This gives us some idea of the rapid increase of this pest in localities where it has gained a foothold. This should be evidence sufficient to show that these localities and finally the fruit section of the entire State will be overrun by this destructive enemy if its progress is not checked.

In reply to the question, "What preventives for this insect have you tried?" *only two* have taken steps in this direction. It is found that the injury thus far is confined mainly to the counties of Ormsby, Washoe, Elko and Douglas. According to the answers received, over 30 per cent. of the apples of these counties are injured this year. It is generally acknowledged that the apples raised in Nevada are of the first quality. When it becomes generally known that this fruit can be profitably raised in this State, it is more than probable that there will be a great increase in the extent of our apple culture.

In order that the orchards now in operation may not become failures, that the codling moth does not gain such possession of the fruit districts as to discourage the planting of new orchards, and that the people may intelligently combat this pest, it is absolutely necessary that they give this subject their active attention, not here and there one, but all who are interested in this branch of business.

If the necessary apparatus seems too costly for a single grower to purchase, let him combine with his neighbors and with them get such tools as are worth having, unite in their use, and all will receive the same benefit.

APPENDIX.

SPRAYING APPARATUS.

In order that my Nevada readers may become familiar with the apparatus used in spraying insecticides, addresses of manufacturers and the prices of such apparatus, this appendix is added.

A number of different forms of pumps and nozzles are manufactured, all of which have many good points, though not all are equally good for the same purpose.

The Gould Manufacturing Company, Seneca Falls, N. Y., manufacture a very good pump, Figs. I, II, III. Figs. 4 and 6 show plan of operation in field work. Their catalogue says:

> "Figs. I, II, and III represent our new double acting force pump, arranged for either hose or gas pipe discharge, for spraying trees, cotton plants, etc., with a solution of tobacco water, or water diluted with paris green or any other poisonous mixture. This pump is especially adapted for diffusing liquids or poison of any kind upon trees, shrubs, or plants, affected by bugs, worms, insects, etc., and capable of doing infinitely more service than any of the smaller and cheaper pumps in the market, as it is of greater capacity, and being double acting, throws a continuous and powerful stream, which can be diffused over a vast area, by means of spreaders or sprinklers.
>
> Either of the discharges may be utilized as a return pipe to mix contents of barrel, although non-soluble ingredients like paris green must be stirred from the bottom to prevent settling.
>
> With these pumps two rows of trees or eight rows of plants can be sprayed, thus saving one-half the labor usually expended."

This pump can be had in two sizes. The prices of the smaller size are $14 and $8 50. Those of the larger size are $16 and $10 50. The outer cylinder of brass in the first grade is replaced by one of iron in the second grade.

Fig. 6 represents an admirable pump manufactured by The Field Force Pump Company, Lockport, New York. Their catalogue says:

> "This pump is fitted with ten feet of discharge hose and a graduated spray nozzle, the above being attached to the pump at the spout 'A.' At the aperture 'B' is attached three feet of return hose, at the lower end of which is connected a discharge pipe, so that, at every stroke of the pump, a small part of liquid is re-discharged into tank near bottom of suction pipe, which keeps the poison and water well mixed. There is also a tight cap furnished, to close up opening 'B' when desired. The pump has three-inch cylinder, and is furnished with iron suction pipe ready to mount on a barrel. Weight 55 pounds."

I would call particular attention to the "return" hose. This may add to the work of operation, but the result is much more effectual, the mixture being kept at an even strength, a point quite apt to be overlooked if some provision is not made for it. This pump complete, not including the barrel, can be had for $12.

Fig. 7 represents the "Climax" force pump which, for one of its size, works admirably. It is very light and convenient, and for light work is to be highly recommended. It is manufactured by R. S. Chapman, 18 California Street, San Francisco. The cost of this punp is $13 50.

Fig. 8 is that of "The Florida" spraying pump, manufactured by Rumsey & Co., Seneca Falls, New York. The company's catalogue says:

> "This cut represents our new and improved force pump, the best and cheapest pump of the class ever put on the market. It has a greater capacity than many more expensive pumps; it will throw a continuous and powerful stream to a height of forty feet or more, and when used with our 'Gem' or 'Dandy' nozzle, it will diffuse a poisonous solution over a wide area, and destroy insects, bugs or worms which attack plants and trees. Price, with three feet of hose, spraying nozzle and sufficient 1¼ inch gas pipe to reach the bottom of an ordinary barrel, $12."

Fig. 9 represents one of the very best of force pumps, suitable for all ordinary work. This pump is manufactured in three sizes, by The Nixon Nozzle and Machine Company, Dayton, Ohio. Fig. 9 represents Size 2 of this pump, which is styled the "Climax." The prices of these sizes are $10, $15 and $20. The third size differs from Size 2 in being heavier and throwing two streams instead of one. In speaking of this pump the company's catalogue says:

> "This pump is made entirely of iron and brass, all parts that have to bear any strain being malleable iron. The legs are made of gas pipe and screw firmly into the base. This pump can be taken apart and shipped in a very small box and easily set up the purchaser. It can be attached to any kind of vessel or tank by means of our brass connections in ten minutes; or the suction hose can be

dropped into a barrel, trough or cistern with equal success. We sell this pump complete, with twenty feet of hose, sixteen feet discharge, four feet suction, two nozzles, and the necessary connections for it, as shown above. We do not furnish the barrel or vessel, but merely show it in this cut to give an idea of what we consider a practical manner of connecting it. Any person can prepare this barrel and rack, as shown above, in a few minutes. The agitator, the handle of which is shown on top of the barrel, is a very complete and successful thing. It costs $1 extra."

In Fig. 10 the Lewis combination force pump is shown. This pump is recommended by many of leading entomologists of the country as being a first class tool for all kinds of light work. One advantage of this pump over the others is that it can be carried and worked at the same time. It is also very cheap, costing $6. It is manufactured by P. C. Lewis, Catskill, New York.

NOZZLES.

The secret of efficient work does not lie in the pump alone. It is all-important that suitable nozzles be used. The "Climax" nozzle, manufactured by The Nixon Nozzle and Machine Company, illustrated in Fig. 11, is one of the best. I quote Mr. Nixon's description of this nozzle. These nozzles cost $1 each.

"No. 3 shows the outer end covered by a wire screen, which cuts the water into spray. No. 2 shows nipple end of same. No. 1 shows the nozzle entire. The nozzles are simple in construction, cannot get out of order, and are very durable, being made of brass. They are fitted with either one-half or three-fourth inch thread, and will fit without difficulty corresponding sizes of gas pipe and hose coupling. They are made of various sizes, numbered from 1 to 6, and will produce spray from the density of fog to any desired coarseness as may be required. Nozzles Nos. 1 to 5 are intended for conservatory, flower garden, orchard and field use. No. 6 is for lawn and street use. The use of the nozzle in creating spray is universal, and by its wonderful adaptation all arsenic and poisonous preparations are brought directly in contact with insects, moths, beetles, worms, etc., eventually exterminating them."

The Pacific Cyclone spray tip, shown in Fig. 12, seems almost impossible to improve upon, where a very fine spray having little force is required. This tip may be attached to a brass tube, so as to spray directly against a bush or small tree, or it may be had in another form, which throws the spray at right angles to the tube or handle, and thus, when thrust among the leaves, will thoroughly spray the under sides of them. This nozzle is manufactured by R. S. Chapman, 18 California Street, San Francisco, and costs $1.

Fig. 13 illustrates the "Gem" nozzle, manufactured by Rumsey & Co., Seneca Falls, N. Y. This nozzle is adjustable, throwing a single stream or a fine spray. In the latter, however, the force is nearly destroyed. This nozzle retails at $9 and $12 per dozen, according to the size.

The "Boss," manufactured by the same company, is represented by Fig. 14. This nozzle permits a solid stream or a flat spray. It retails for $12 and $14 per doz.

It will be seen that not all these pumps and nozzles are suited to the work of spraying for the codling moth. The pump having the force and the nozzle producing a fine spray and not destroying the force are such as should be used in fighting the codling moth. My own experience leads me to say the Nixon pump and nozzles do as good work as any.

F. H. HILLMAN.

January 1, 1890.

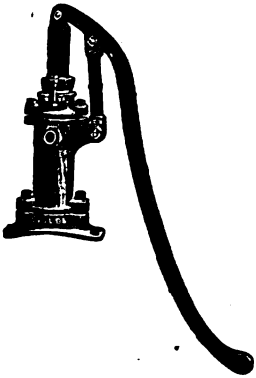


Fig. 1.

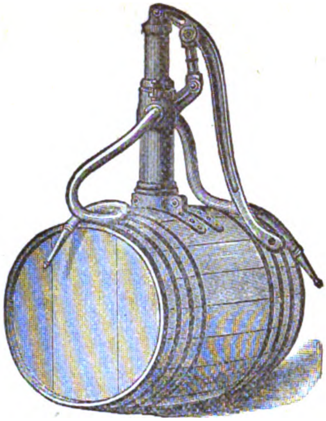


Fig. 2.

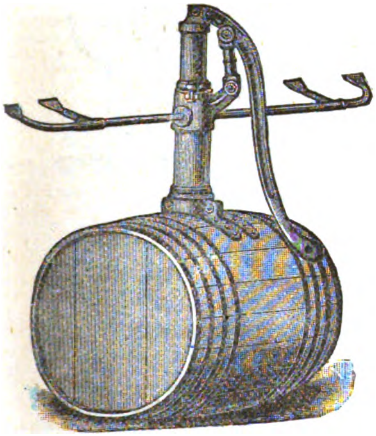


Fig. 3.

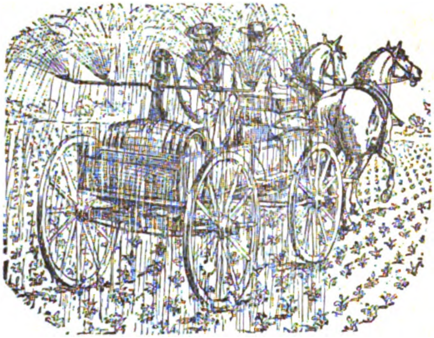


Fig. 4.

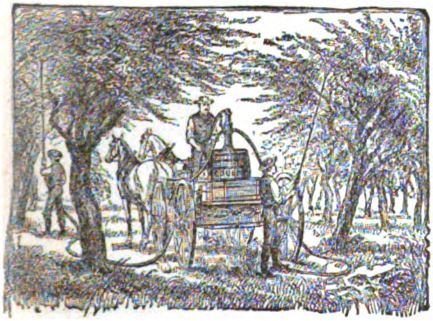


Fig. 5.

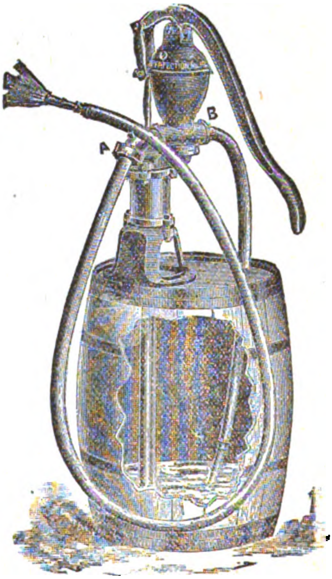


Fig. 6.

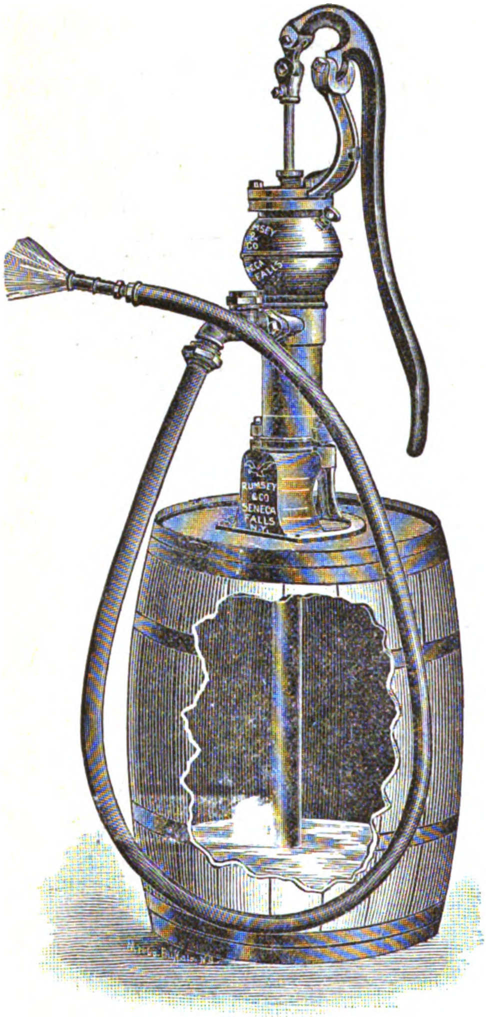

RUMSEY & CO SENECA FALLS
RUMSEY & CO SENECA FALLS N.Y.

Fig. 8.

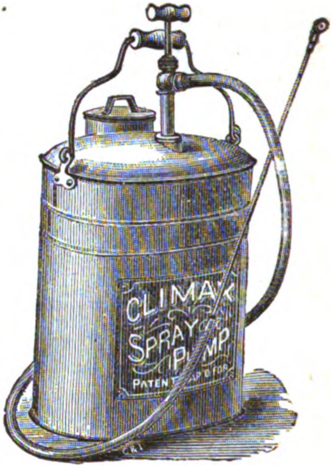


Fig. 7.

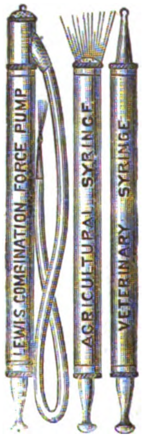


Fig. 10.

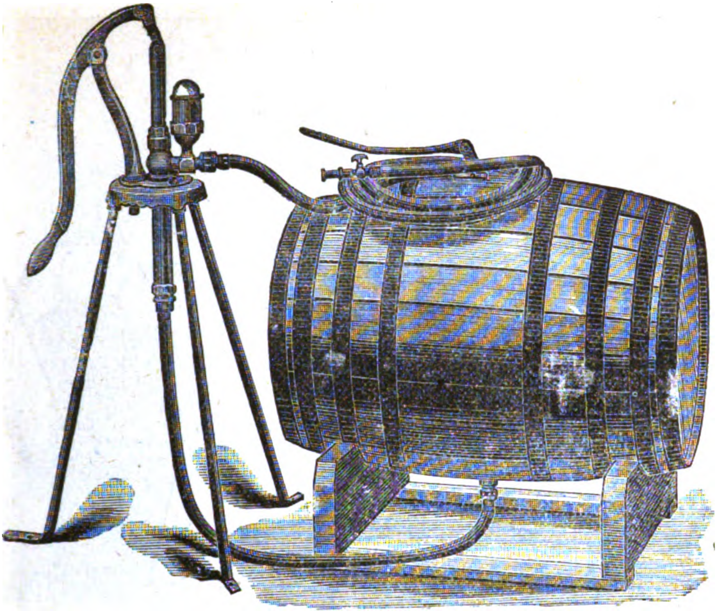


Fig. 9.

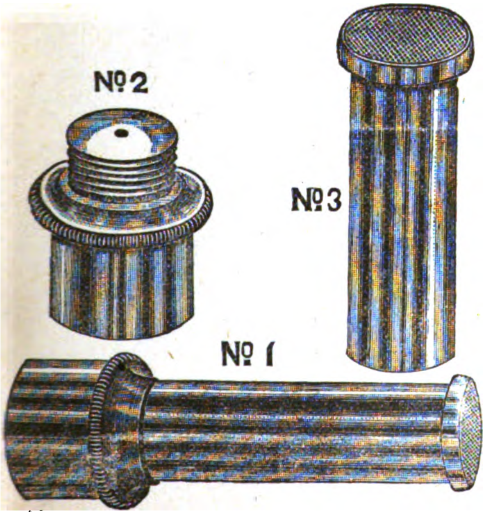


Fig. 11.

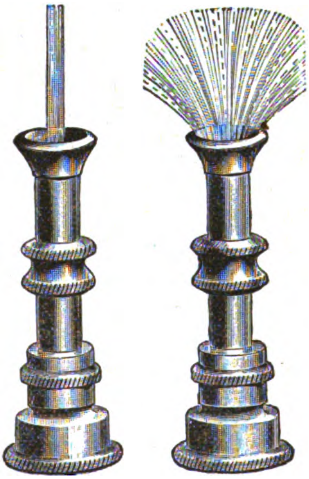


Fig. 13.

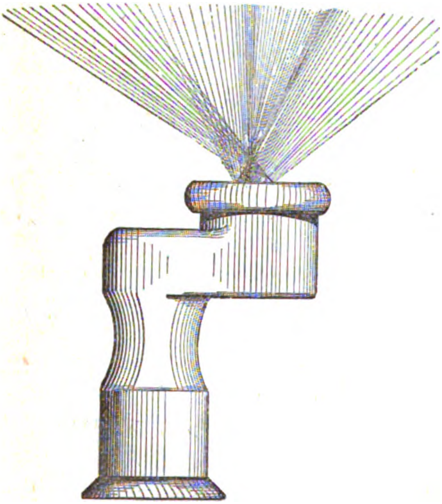


Fig. 12.

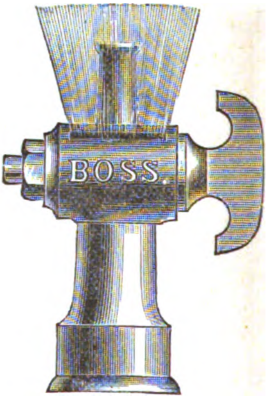
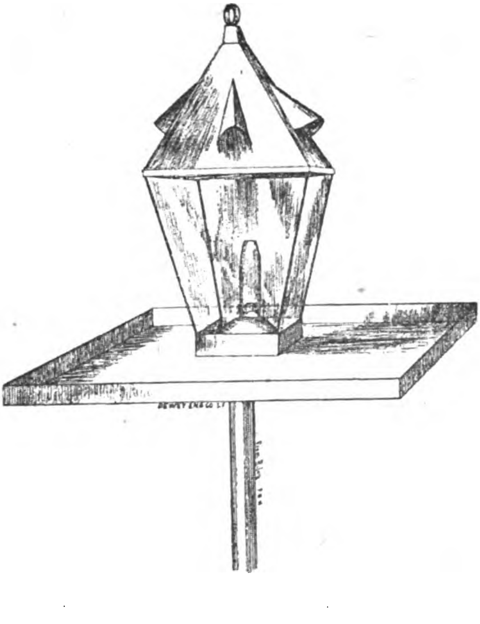


Fig. 14.


DEWEY ENG CO

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

RENO, NEV.

S. A. JONES, Director. [BULLETIN No. 9.]

A SERIOUS ROSE PEST.

(*Lithophane antennata*—Walker.)

A serious insect pest is at present creating great havoc among the rose bushes by burrowing into the buds, and, in fact, frequently removing all of the flower with the exception of the enveloping calyx. In some of the cases coming under my observation, this injury is confined to a part only of the buds, but in many cases, all of the buds are either seriously injured or entirely destroyed.

The injury seems to be confined exclusively to the buds before and at the time of opening. The tender internal vegetable tissues of the bud are most palatable to the insect; and, to gain these, a hole, varying in diameter from one-quarter inch to one-half inch, is projected either into the thickened base of the bud, extending upward to the tender base of the petals at the center of the flower, or, the incision is made at the side of the calyx, and extended through into the petals within. In the first case, the petals being cut at the base, wither and fall on the opening of the flower. In the second case, the parts of the flower are so disfigured that all beauty is gone, and, as in the first case, the rose-grower's labor is for naught.

The general appearance and mode of procedure of this insect, are identical with those of the apple and peach fruit borer—*Lithophane antennata*—and it is, without doubt, the same species. Thus we are not dealing with a new pest, but one which, in many sections, has proven itself very injurious to the apple and the peach. Indeed, this immediate vicinity is not free from its depredations, upon the apple at least, for I am at present finding both the insect and the results of its work among the apple trees. The insect is to be found frequently resting within the curled edges of a leaf, the curls of which are retained in position by a web loosely spun by the insect. The injury done to the apple and the peach is very similar to that in the case of the rose, excepting that here the incision is usually made into the fruit after it is well formed, though this is not always true.

The mature stage of this insect is that of our very common night-flying moths The moth has one and one-half inches expanse of wing, and is of a dull ash-gray color, with variegations of gray and brown. The front wings are farther marked by an oval and a reniform spot on each, which are characteristic of the insects of this family—the *Noctuidæ*. It is while in this stage that the eggs are laid. Judging from the position of the minute young larvæ when found, these eggs, in the case of the rosebud injury, are deposited at the base of the bud and at the sides of the flower sepals. The larvæ resulting from the hatching of these eggs at once commence devouring the bud, which they continue until their maturity is reached. As this stage is about completed, according to Saunders, the larva makes its way into the ground and spins about it a silken cocoon, in which it passes the chrysalis stage, from which it immerges as the imago, or mature moth, and completes its life cycle.

As in the case of the familiar and destructive cut-worms, which belong to the family *Noctuidæ*, the larval stage of this insect is that in which it is destructive.

The full-grown larva is about one and three-eighths inches long, cylindrical, free from hairs, and presents a light-green colored background. Many creamy-white spots are sprinkled over the body, which bears a narrow but distinct creamy-white dorsal line, and a somewhat wider one along each side. These lateral stripes are widest at the posterior end of the body. Midway between the lateral and dorsal stripes is a distinct line of cream spots, and below each lateral stripe is a somewhat broken line of the same. The anterior dorsal margin of the first segment back of the head bears a white collar.

This insect is not to be confounded with the rose slug, *Selandria rosæ*. The rose slug is the larva of a saw fly, an insect belonging to the same order as the bees, and bearing four membranous wings. The mature slug is about half the length of the rosebud pest and has twenty-two legs, while the latter has but sixteen. The slug confines its depredations to the leaves, where it devours irregular patches of the upper surface, while the insect in question seems to confine itself in all cases to the buds, and seeks the internal tissues in preference to the dermal portion, as is true in the case of the rose slug.

Regarding the most practical portion of the information relative to this pest, namely, remedies for its prevention or extermination, not much assurance regarding many of the usual means employed in the destruction of insect pests can be given at the present time. Future experiments may establish the reliability of one or more of the methods employed at present, or point out some new means not yet generally known. It is possible that in aggravated cases, lights surrounded by some sticky liquid, as shown in Fig. 1, will prove destructive to many of the mature moths as they come to lay their eggs. Should this prove true, it will be due to the probable fact that the moths are night-flyers, and that they are more or less attracted by light, as are many of the so-called "millers." It may be that crude carbolic acid placed in proximity to the rose bushes, will prove so offensive to these moths that they will give the bushes a wide berth, and thus be forced to de-

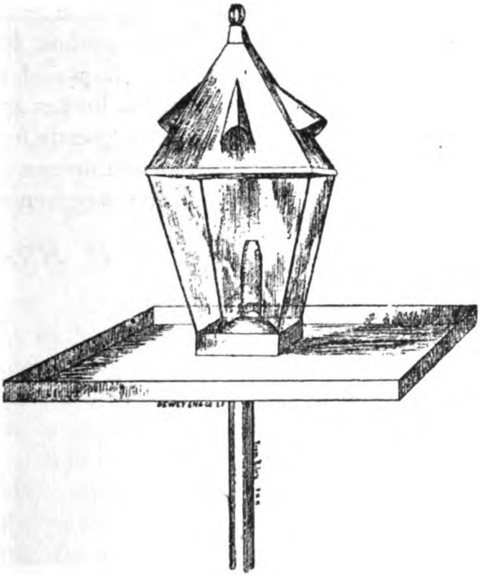


Fig. 1.

posit their eggs elsewhere. This proves a very successful preventive in the cases of several species of injurious insects.

Of the experiments tried at the Experiment Station, the spraying upon the bushes of the poisons Paris green, London purple, and white hellebore, aiming to kill the feeding larvæ, has proved unsuccessful, although these were applied in liberal quantities. Could the poison be found evenly distributed upon the bud by the larvæ immediately upon hatching, that their first meal might consist of it, it is possible that the desired end might be attained. The experiments thus far tried at the Experiment Station seem to demonstrate conclusively that the use of these poisons in proper quantities produces no injury to the leaves, buds; or opened flowers even, of the rose.

While no assertion is made relative to the real efficiency of the above measures as means for the destruction of this pest, it is hoped that, as suggestions, they may aid the enthusiastic grower in saving his roses from a dangerous enemy. Until some better method is found, hand picking may be said to be the most effectual. It is said by those who have forcibly thrown a spray of water upon the bushes at frequent intervals, that the proportion of injured buds is greatly lessened. This is probably due to the larvæ being dislodged and thrown to the ground. Could they then be destroyed by treading, the effectiveness of the operation would be greatly increased.

F. H. HILLMAN.

Reno, May 31, 1890.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

RENO, NEVADA.

S. A. JONES, Director. [BULLETIN No. 10.]

THE PEAR AND CHERRY SLUG.

(*Selandria cerasi*—Peck.)

Many of the growers of pears and cherries in Western Nevada are finding the leaves of their trees destroyed by a serious insect pest—the pear and cherry slug. The leaves are not completely eaten away, as they frequently are by many of the destroying catterpillars. but great patches of the upper surface of the leaves are devoured by the slug. The veins and lower surface of the leaf are left, but it soon withers and dies, its function, as an important organ of the thrifty tree, gone.

At this date, the trouble is not equally bad in all parts of Reno. In some orchards, the insect is only beginning its work, while in others, its ravages have been continued for three weeks or more, and many trees coming under my observation are divested of nearly every healthy leaf. In August of 1889, I noticed many trees from which the entire foliage had fallen. This should not have taken place till the frosts of Autumn had brought about natural defoliation.

To realize the evil, one must consider the future results. Owing to the fact that the fruit is not attacked, attention to the injury to the foliage is apt to be neglected, thus allowing the succeeding, if not the present, crop of fruit to suffer.

Were this insect attack to take place late in Autumn, that the destruction of the leaves would be nearly coincident with their natural period of falling, the injury would be reduced to a minimum. As it is, the vitality of the tree is greatly impaired in prematurely putting forth a new growth of leaves, which should not make their appearance till the following Spring. This impaired vitality is much more likely to result in a diminished fruit production than leaf production the following year, for there is always a supply of latent leaf-buds to provide for deficiencies. Among leaf-bearing trees, an individual may continue life from year to year without fruit production, but not without the production of foliage.

The insect in question is the larva of a saw-fly, a small, jet black, four-winged fly, belonging to the same order as the bees—*Hymenoptera* (membranous wings)—and to the family *Tenthredinidæ*. It is technically known as *Selandria cerasi.*

The slug or larval form, represented at *b b* in the figure, is that in which we are most interested. It is about 9-14 of an inch in length, of a dark olive color, with a peculiar slimy skin. The head is dark brown, small, and almost hidden from view by the enlarged anterior body. The posterior extremity of the body abruptly becomes smaller. When the larva is at rest, this extremity usually projects upward. This larva has twenty legs, while no other, outside of the family of saw-flies has a greater number than sixteen. "On first quitting the egg, the larva is nearly white, the head brown and large In the course of twenty days, it throws off four skins, each of which it generally eats at once. It remains in the fifth viscous skin six days, and acquires its full growth, and quits the skin, leaving it adhering to the leaf, and appears in a clear yellow skin, not viscous."—Peck. This form is represented at *g* in the figure, enlarged twice, the true length indicated by the hair line above. Shortly after this last change the larva disappears in the ground to the depth of three or four inches, where it spins a silken cocoon, within which it passes the pupa stage.

If this be the first brood of the season, in the course of fifteen or twenty days the mature insect emerges in the form represented at *c*. The female thus brought forth is sluggish in her movements, as she flies from leaf to leaf, on her mission of egg-laying. In this performance she is aided by a very peculiar and interesting organ—a veritable saw. All the members in this family are thus provided, though the forms of the saws in the different genera differ greatly. Thus it is that the term saw-flies is applied to them all, and we recognize as relatives of our insect, the rose and currant saw-flies—*Selandria rosæ* and *Nematus veutricosus.*

This saw, which plays such an important part in the economy of the insect, is well worthy of notice. The organ is composed of six parts, there being two each of three sets. At *e* in the figure is represented one of the two saw blades which rest side by side. Each of these has a row of teeth along its convex margin, which is 1-19 of an inch in length, from heel to tip. These teeth are of two different forms, one having comparatively entire margins alternating with those of the other form, each of which has several smaller teeth, thus giving the blade a doubly serrate cutting edge. In addition to these, there is a row of fine teeth along the side of the blade, indicated by the row of black spots along the side of the blade as shown at *e* in the figure. These serve to increase the width of the incision made in the leaf. The edge opposite the teeth is concave, somewhat thickened, and slides within a second piece, which serves to guide and strengthen the saw-blade. In function, this piece may be very appropriately likened to the iron guide holding the knives of the reaper or a mower. The other saw-blade is provided in like manner, and on the outside of all, on either side, is a shield-like stylet. These complete the saw, which corresponds to the sting of the bee, but which, in this insect, forms an ovipositor, with which the female prepares the way for the deposition of her eggs.

The manner in which the saw is used is as follows: The female fly alights on the under side of the leaf, when her saw, which has rested in a groove in the central posterior abdomen, is brought to a position perpendicular to the surface of the leaf. A short narrow slit is now cut through the lower surface and inner tissues of the leaf, reaching almost to the upper surface. This accomplished, a single egg is deposited at the extremity of the cut. As the larva hatches from the egg the epidermis separates from the tissues beneath, causing that portion of it at the point of separation to present a minute round white spot on the upper surface of the leaf, shown at *f* in the figure. Later the larva breaks a crescent-shaped slit through this epidermal tissue, and escaping from its narrow cell, starts on its tour of destruction. One may see the minute slit made by the saw of the female directly beneath this whitened spot.

This pest is not a new one, but one with which writers on economic entomology have long been acquainted. It is one of many closely allied injurious species. It may be identified in the larval stage as feeding upon the upper surface of the leaves of the pear and cherry (Packard states that it is found on the plum and mountain ash), by its slimy olive colored skin, whence the name "slug," its twenty feet and greatly enlarged anterior body.

The mature female fly may be recognized by her jet black, short, thick body, her nine-jointed antennæ, of which the first two joints are somewhat globular, the third as long as the fourth and fifth, which with the remaining four taper to a blunt-pointed ninth segment. The anterior and middle legs below the knees are dusky white, and most specifically, each anterior wing has a clouded portion, as shown in the figure at *d*.

REMEDIES.

This is not a difficult pest to combat; its destruction is cheaply and easily accomplished by the use of any one of several insecticides. The use of Paris green and London purple in water mixture sprayed upon the foliage is recommended. A disadvantage in this, however, is that if a fruiting tree is thus treated it causes to be left on the fruit rather late in the season a poisonous arsenical compound, which, though it may not be sufficient to do any damage, is nevertheless distasteful to many. The viscid condition of the larval skin suggests the use of lime, ashes or road dust, which cling to the larva, but I doubt the efficacy of this in some cases. A larva about to shed its skin would doubtless do so, coming out fresh and clean, none the worse for its rough treatment.

The experiments with tobacco decoction, white hellebore and buhach, performed at the Experiment Station, prove the value of these as remedies for the pear slug. A double handful of refuse tobacco was boiled and the decoction diluted to form eight or ten gallons. A table spoonful of white hellebore to five gallons of water, and the same amount of buhach in the same amount of water, were separately sprayed upon different trees, resulting in each case in the death of nearly all the slugs. A second application took them all. These being vegetable compounds, no injury to the foliage is at all likely to result, which is not always true in the use of inorganic compounds.

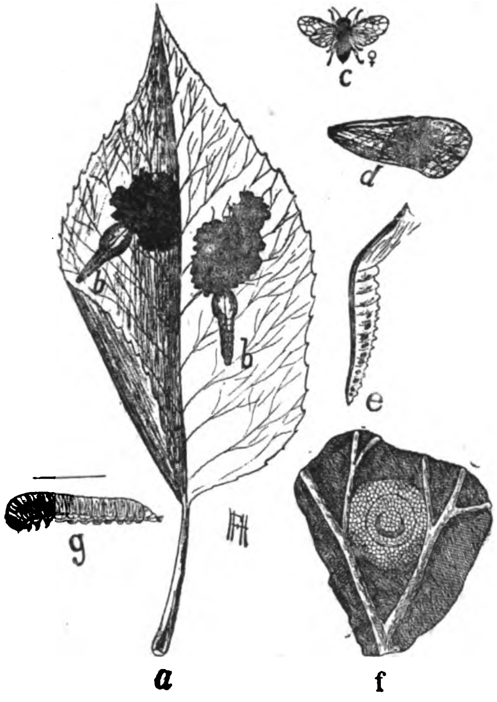


FIG. 1.—*a*, leaf showing patches of upper surface eaten away; *b b*, larvæ of saw-fly at work; *c*, mature female saw-fly; *d*, anterior wing (enlarged three and one-half times); *e*, blade of saw (greatly enlarged); *f*, portion of leaf, showing place of exit of young larva (greatly magnified); *g*, larva after last moult (enlarged twice).—*Original.*

F. H. HILLMAN.

Reno, July 31, 1890.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

RENO, NEVADA.

S. A. JONES, Director. [BULLETIN No. 11.]

PLANT-LICE INFESTING THE APPLE.

(*Aphis mali*–Fabr.; *A. malifoliæ*–Fitch; *Schizoneura lanigera*–Haus.)

No insect pest has called forth so much inquiry during the dry seasons of 1889-90 as have the plant-lice infesting the apple. The ravages of these minute pests are not confined to this section alone, but our exceedingly dry climate, which is advantageous to their existence, permits them to become a matter of no mean importance to the apple-grower.

In order that those interested may become familiar with the nature of these insects, this short and incomplete bulletin is issued.

The plant-lice form the large and comprehensive family of insects, *Aphidæ*, from which the generic and common name *Aphis* is derived. Nearly every species of plants at some period of its existence is preyed upon by one or more species of plant-lice. The usual color of the lice is a vegetable green; yet some are brown, some black, and one species coming under my observation is of a deep carmine red. Frequently an excretion from the body gives a delicate bloom to the body surface. In some species this produces a decidedly woolly appearance.

The plant-lice are bugs, and, like the bed-bug, each is provided with a pointed sucking beak, which is thrust through the external surface, whether it be bark or leaf, of the plant infested. Here they rest, sucking up the plant's life-blood. That in the case of apple trees this constant withdrawal of sap is detrimental to thrifty growth, is evident in the curled leaf, the stunted branch; and, in the case of injury by the root-lice, the general unhealthy and dying appearance of the trees.

Excepting the case of the woolly lice already referred to, the various species are represented by a winged and an apterous form. The reproduction of these insects is at once singular and interesting. While the attendant circumstances in the yearly history of different species differ somewhat, the general statement may be made that the lice of a single season are all females, bringing forth their young alive, there being several generations each season, the last of which includes males, which mate with the females of the same generation late in Autumn. Eggs are laid by this generation of females in protecting places, such as about buds, and in cracks in the bark. These eggs hatch with the bursting of the buds in the Spring, and the first of several generations of females take up again the work of destruction.

Many species of plant-lice have two horn-like projecting tubes from the upper posterior end of the body from which exude at frequent intervals minute drops of a transparent, sweetish liquid. So copious is this excretion at times, that the leaf upon which the lice rest, and even adjacent ones, sometimes become coated with a thin layer of it. Attracted by this sweet material, the ants are frequently found in great numbers running among the lice and along adjacent twigs. Many have considered these lice the cause of the injury to their trees, but in this they are wrong, as the ants do no damage whatever.

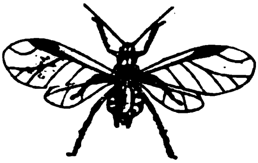


Fig. 1 (*after Weed*)

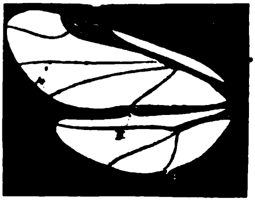


Fig. 3 (*original*).

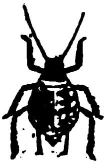


Fig. 2 (*after Weed*)

Fig. 1 is that of a winged female, greatly enlarged. The honey tubes may be seen projecting from the posterior end of the body.

Fig. 2 represents an apterous female *i. e.*, one having no wings.

In Fig. 3 the wings of one side are shown, greatly enlarged. It will be noticed that the venation is very simple. The vein marked A, represented as simple in the cut, is simple, once, or twice forked, in different genera. At B is a hook on the hinder wing, which catches a fold in the margin of the anterior wing, thus holding them united during flight.

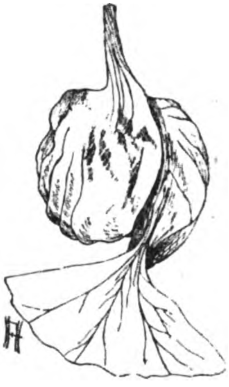


Fig. 4 (*original*)

Fig. 4 is that of a gall, common on the cottonwood. It is formed usually at the junction of the stem and blade of the leaf. On examination, these galls will be found to be enlarged and twisted growths of leaf stems. A narrow slit always separates the two halves of the gall, which, being opened, show the gall to be filled with a great number of lice, mingled with a whitish dust and numerous drops of honey-dew.

With the foregoing statements relative to the plant lice in general, let us consider those species infesting the apple especially.

There are two species—*Aphis mali* and *A. malifoliæ*—which feed on the leaves, causing them to curl; a woolly species—*Schizoneura lanigera*—infesting the bark, and a supposed variety of the latter attacking the roots.

Those species attacking the leaves are, in general, of a green color; those bearing wings being darker and smaller in body than the apterous form. The third discoidal vein (marked A in Fig. 3) is twice forked, and the honey-tubes are fairly prominent. These collect in great numbers on the under surface of the leaves, which soon become curled, and frequently appear to be dried or slightly burned. To older trees the liability of permanent injury is not so great as in the case of young, growing trees. On these the lice collect on the most tender spots—the young leaves of the growing twigs. Owing to the tender condition of this young growth, the lice are usually much thicker here than at any place on an older and more mature tree.

Schizoneura lanigera, a species differing from those preceding, collect upon the twigs and bark, and give to them a woolly appearance. These are commonly known as the "Woolly Aphis." But few of these are winged, The body is dark brown in color, but the greater part of it is covered by a white flocculent excretion, nearly hiding it from view. The individuals of this species collect about scars of amputated limbs, splits in the bark, and in the angles of twigs and leaf stems. So numerous do these frequently become as to form a dense mass. This species obtain their food in the same manner as those on the leaves, and the same treatment for their destruction will apply in either case.

Lastly, we have to deal with those lice infesting the roots of the tree. These are considered by many to be a form of the Woolly Aphis. They produce knotty galls on the smaller roots, and draw away the tree's nourishment as soon as it is taken from the ground. The tree assumes a sickly appearance, which, in the course of a year or two, results in death if the pest is not checked.

NATURAL ENEMIES OF THE PLANT-LICE,

Man is not left to combat these destructive pests alone. They have various natural enemies that destroy millions of them. We have in many birds, fungous diseases, and in numerous other insects, friends that work great good in diminishing the vast number of these lice.

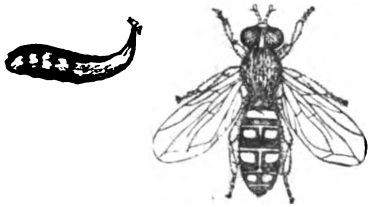


Fig. 5.

In Fig. 5 is represented a Syrphus fly, which lays its eggs among the clusters of lice. The maggots hatching from these feed upon the lice. The figure shows one of these maggots holding aloft a louse. The louse is pierced by the hook-like mouth-parts of the maggot, which sucks away its life-blood, till but a collapsed body-wall remains. These maggots are very common, and a by no means small number of lice are destroyed by them. The mature flies are recognized by their bright yellow markings, as they flit from leaf to leaf in laying their eggs.

Prominent among our insect friends are the Lady-bird beetles.

These dispose of many lice in both the larval and mature stages

Fig. 6 represents two mature beetles and a larva. All are familiar with the Lady-birds, with their hemispherical bodies variously marked with black spots.

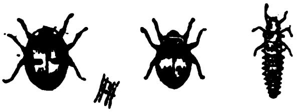


Fig. 6 (original).

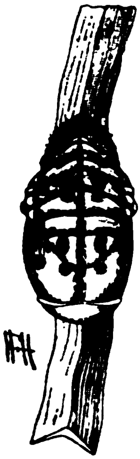


Fig. 7 (original).

Fig. 7 represents the pupa of a Lady-bird, greatly enlarged, and suspended from a leaf. This is the intermediate stage between the larva and mature beetle.

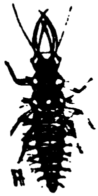


Fig. 8. (original)

Fig. 8 illustrates the "Aphis lion," so called because of the great number of Aphids, or plant-lice, it destroys, and the voracious manner in which it attacks them. Like the larvæ of the Syrphus flies, this is to be found among the clusters of lice. It can be distinguished from the others by its exceedingly long jaws and quicker movements. I believe the Aphis lion is more common among the Woolly Aphis than are the larvæ of the Syrphus flies.

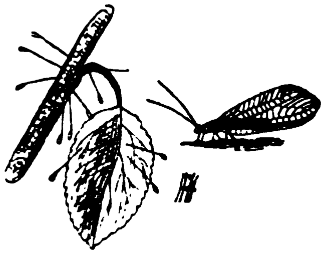


Fig. 9 (original).

Fig. 9 is that of the Chrysopa fly, the mature form of the Aphis lion. The figure represents the natural size of the insect, which is green in color, the wings forming a steep roof above the back. The female lays her eggs among the lice, sometimes singly, and sometimes in clusters. These eggs are peculiar in the fact that they are each provided with a stem, or stalk, by which they are attached to the twig or leaf.

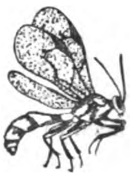


Fig. 10

In Fig. 10 is shown the imago of aparasitic fly that destroys myriads of lice. This insect deposits a single egg in the body of a louse, repeating the operation as she flits from one victim to another, till her supply of eggs is exhausted. The minute worm hatching from the egg draws its subsistence from the body of its louse host, which soon dies, though continuing to remain (*after Cordley*).

on the leaf upon which it was feeding. The body of the louse becomes swelled, as represented in Fig. 11, and takes on a light wood color. This is now but a brittle shell, within which the larva passes the pupa state, and emerges a mature fly, as shown in Fig. 10. The lice of the apple seem to be much less affected by this parasite than are those of the cottonwood and various species of *Artemesia* (sage-brush).

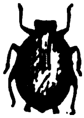


Fig. 11
(*after Cordley*)

The results of observation upon the enemies of the plant-lice of the apple show that, in this immediate vicinity, at least, the greatest number of lice destroyed have fallen victims to a disease which causes them to assume a dark brown to black color, death resulting in a short time.

As in the case of parasitism, these diseased lice become swelled, and remain fixed in position as in the act of feeding. The under surface of the body becomes much depressed, a condition not true in parasitism.

Specimens of these diseased lice examined by Prof. C. S. Crandall, of Fort Collins, Colorado, showed a fungus mycelium to be abundant. Bacteria were also present. Owing to the limited time at his disposal at the time of examination, Prof. Crandall was undecided whether the exciting cause of the disease is fungoid or bacterial. Whichever of these be the true cause, it is a consoling fact that immense numbers of the lice are destroyed by this disease among them.

REMEDIES.

The enterprising apple-grower will not depend wholly upon these friendly allies for the riddance of the pests. They are easily destroyed, but he must give the matter attention, and follow up his work with repeated treatment. Apparently successful applications of remedies will still leave a few lice undestroyed, which, owing to their wonderful powers of reproduction, soon make good the loss sustained. In the case of *Aphis mali* and *A. malifoliæ*, the winged females from neighboring trees will soon restock the treated trees. Hence the necessity of vigilance and repeated efforts in combatting plant-lice.

Kerosene emulsion—formed by adding to one part of a boiled mixture of one-half pound common soap and a gallon of water, two parts of kerosene, thoroughly mixing, and diluted with cold water to form fifteen to twenty parts—is an efficient remedy.

A double handful of refuse tobacco, boiled in a gallon of water to form a strong tea, and diluted to form six or eight gallons, is a valuable and easily prepared remedy.

Carbolic soap, such as sold in the shops for disinfecting purposes, dissolved and so diluted. that a decided odor of carbolic acid still remains, is another effective remedy.

These three remedies have been thoroughly tested at the Experiment Station, and their value, if properly applied, verified.

In treating the leaf and bark lice, these should be sprayed upon the infested surfaces, thoroughly wetting them, in order that as few as possible of the lice shall escape contact with the liquid. Regarding the various pumps and nozzles suitable, the reader is referred to the Appendix of Bulletin No. 8 of this Station.

In the case of the root lice, owing to their subterranean position, they are harder to combat. However, by digging a shallow trench about the infested tree in Autumn, and pouring in either of the above remedies, allowing it to soak down among the roots, will doubtless attain the desired end. It must be borne in mind, however, that kerosene can be used for this purpose with great care only, possibly not at all.

A cake of hard soap placed in the crotch of the tree, so that it will be gradually washed down and into the soil about the roots by the rains, is recommended.

F. H. HILLMAN.

Reno, September 5, 1890.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 12.

SUGAR BEET CULTURE.

RENO, NEVADA, APRIL, 1891.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

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SUGAR BEET CULTURE.

R. H. McDOWELL.

It is the intention to make experiments at this station with sugar beets this summer. But as nothing of the kind has been attempted heretofore—the season for sowing being near—and requests coming almost daily for seed, it was thought possible for us to lend assistance to farmers of Nevada who would like to try sugar beet culture, by publishing essential points taken from late bulletins

Extracts have been made from the following: U. S. Department of Agriculture, Division of Chemistry, Bulletins No. 3 and No. 27; Bulletin No. 71, Michigan Chemical Department; Bulletin No. 26, Wisconsin Experiment Station; Bulletin No. 14, Colorado Chemical Department; Western Beet Sugar Company, San Francisco, Cal,

Experience has shown that the sugar beet reaches its highest development in north temperate latitudes. So far as the production of the beet with high tonnage is concerned, it is found that it will grow far to the south, but beets grown in such localities, upon the whole, are less rich in sugar and less suitable for the manufacture of sugar than those grown further north.

BEET SUGAR IN THE UNITED STATES.

The area adapted to the growth of sugar cane in our country, for climatic reasons, is very limited, while the area suited to the growth of sugar beets embraces millions of acres. While France, Germany, Austria and Russia have pushed forward this industry to astonishing lengths, we have stood idly by, an importer and consumer, but not a producer, while these countries refuse to take a pound of our pork in exchange. Less hogs and more beets may remedy this evil.

This country paid Germany $16,000,000 for sugar in 1889, while she still refuses to admit a pound of our hog products.

The following suggestions worth noting are taken from Wisconsin Experiment Station Bulletin No. 26:

THE PRACTICABILITY OF PRODUCING SUGAR FROM BEETS IN WISCONSIN.

"Within a generation, two efforts have been made to produce sugar from the beet in this State, and although in both cases a considerable amount of sugar was produced, the fact remains that operations were discontinued, showing plainly that all conditions of success were not met. For a time our people would have nothing to do with the sugar beet, but time has healed the trouble, and now very considerable interest is awakened, and people are again ready to put their money in the venture. This Station will not have done its duty unless it points out clearly the true situation of affairs, and urges great care and the use of the highest business judgement in every effort put forth from this time on.

"In regard to growing beets for the manufacture of sugar, our farmers should first of all understand that it is a new line of agricultural effort, and that a profitable crop requires close care, much patience, and a very considerable amount of labor of that kind for which they have had little training or experience. No matter what kind of machinery may be invented, the fact still remains that weeds will spring up close about the beets, and that these must be removed, that the beets must be thinned, and a considerable amount of painstaking labor applied to secure a maximum yield of beets containing a high percentage of sugar. Any abuse of the crop not only diminishes the yield of beets in weight, but also the percentage of sugar, thereby making a double cut on the profits. The farmer who has been accustomed to breaking his corn land with a sulky plow, planting with a riding corn planter, and tending the crop with a sulky cultivator, will find a great change when he undertakes to grow beets. All of these points should be carefully considered lest enthusiasm run away with our judgment. The sugar beet is a thoroughbred, and must be treated as such. When it is, other conditions being favorable, the profits will be found very satisfactory. It is well for our farmers not to anticipate growing rich out of a few beet crops. Experience has shown that money from the beet comes much the same as that earned in any other way, and only those whose soil is adapted to the crop and who grow it judiciously will make more than bare expenses.

"Nothing here said is given out for the purpose of discouraging any venture, but rather that we may fully understand the situation. Enthusiasts and those interested will paint the other side of the picture."

CLIMATE FOR SUGAR BEETS.

The sugar beet for the development of the largest amount of sugar requires a temperate climate and well distributed rainfall. Unlike the cane, it does not produce a large amount of sugar in a hot climate. A climate with a mean summer temperature of 70° F., with an average monthly rainfall of not less than two inches for the summer, is well adapted to the growth of sugar beets of the best quality.

A mean temperature of 70° F. in the summer, however, must not be regarded as the only element of temperature which is to be taken into consideration.

In those localities where the winters come early and are of unusual severity will be found greater difficulties in the production of sugar from the sugar beet than in those localities where the winters are light and mild, although the mean summer temperature of both localities may be represented by 70° F.

As an illustration of this difficulty may be cited Northern Nebraska and South Dakota, where the winters are of great severity, and Southern California, where there is scarcely any winter at all. The mean summer temperature of these localities is about the same, but the continuation of a summer temperature through the winter in Southern California will greatly favor the manufacture of the beets. In Northern Nebraska and South Dakota the beets which are to be manufactured during the winter time have to be protected by expensive silos. In Southern California and other places similarly situated the beets can be protected without any covering, or at most, with only a slight covering of leaves or straw. The season for planting in a mild climate is also longer; for instance, in Southern California planting can commence as early as February and continue till June, thus giving a beet crop coming continuously into maturity from the 1st of August to the 1st of December.

In other localities the planting must be accomplished in a short time, say from the 10th of May till the 1st of June. Before the first of these dates the ground will be too cold for planting, and after the second the season will be so late as to prevent the maturity of beets before frost.

VARIETIES OF BEETS.

All kinds of sugar beets are botanically identical with the common garden beet, Beta Vulgaris. The differences in varieties have arisen by reason of special selection and culture, producing a pure strain of some valuable peculiarity in the beet.

These accidental valuable qualities by careful selection have become fixed, and are associated with certain external properties which have thus come to be regarded as distinguishing characteristics.

The certainty that the seed has been grown according to the most scientific methods is of greater importance to the beet grower than the variety. The beet has reached such a high state of perfection as to make the least degree of laxity in its treatment exceedingly dangerous to its qualities.

In Germany the farmer is not allowed to furnish his own seed, but all the beet seed is furnished by the manufacturer. Distinct varieties of beets have been secured by cultivation and selection, as distinct as are the breeds of cattle in stock raising, and the manufacturer would no more use seed of unknown pedigree than the stock raiser use scrubs in developing his herd.

Not only must the seed be from approved varieties known to be rich in sugar, but each beet is tested for its richness before it is planted for seed, and all beets below the standard are respected in planting for seed.

By this process of breeding and selecting the contents of sugar in the beet has been raised from 6 per cent (in 1747) to 20 or even 22 per cent in some special strains of beets. A beet that contains less than 12 per cent of sugar in its juice is hardly worth manufacturing, and the value increases rapidly with the increase in percentage of sugar.

A beet giving a large cultural yield rich in sugar involves no more cost to the grower in its production than one giving a small yield and low saccharine value.

It is therefore useful to choose those which will give the greatest returns and be at the same time the most satisfactory in every way to the grower who must produce them and to the manufacturer who must extract the sugar.

Henry T. Oxnard, President of the company at Grand Island, Nebraska, says: "We have a method by which we are enabled to secure the best results in the beet cultivation, and that is by proper propagation of the plant. We weed out those that we know would produce inferior results, and we keep on watching with great care and allowing nothing to produce seed that will not enhance the valuability of the seed. Producers are ascertained by boring out a quantity of the meat of a beet, after which the hole is plugged and a stake driven into the ground to mark that particular vegetable. If, from analysis, the beet gives promise of rare quality it is allowed to go to seed. No seed is taken from beets the quality of which is not proven to be of the highest order, and we desire to attain this degree of excellence in the propagation of the beet seed from which to grow our sugar producers."

SOIL.

The sugar beet does not require a particular kind of soil for its proper production. In general, soils are described for practical purposes as clayey, sandy, loamy, or alluvial soils; all of these soils will produce beets. The black prairie soils also have been found, with proper cultivation, to produce excellent beets. Generally the least favorable soils for the sugar beet are a stiff clay, which is cultivated with difficulty and readily packs under the influence of hard rains and hot suns. and virgin soils or those especially rich in organic matter or alkaline salts. Perhaps the best soil may be described as a sandy loam; a soil containing a happy equilibrium between organic matters, clay and silica.

In general it may be said that any soil which will produce a good crop of Indian corn, wheat or potatoes, will, under proper cultivation, produce a good crop of sugar beets. An open porous soil in which the beet may freely penetrate the sub-soil, and not be pushed out of the ground by its own growth, without stagnant water in the sub-soil, or hard pan. It should not contain fresh manure. If the ground requires manure it should be applied in the fall and plowed under, so as to be well incorporated with the soil before the beets are planted.

In Germany a clover sod is rejected for this crop.

PREPARING THE SOIL.

The field in which beets are to be planted should be selected and plowed in the fall to a depth of at least nine inches. The plow in each furrow should be followed by a subsoiler, which will loosen the soil to the depth of six or seven inches more. In the Pajaro Valley, California, the deep plowing is given whenever the land is fit, during the fall, winter or spring; it should be at least ten inches deep, or deeper if possible. If land has never been plowed more than five or six inches deep, or if the layer of top soil is thin, care must be exercised in regard to bringing new soil or subsoil to the surface, as it may hurt the beets on account of its acidity.

In such cases a subsoil plow should be used to break up the objectionable ground to the requisite depth without bringing it to the surface.

Culture in the Pajaro Valley is given by the Western Beet Sugar Company of San Francisco. They also give the following figures on plowing:

"Depth of plowing, 4 inches; yield per acre, 2 tons 1,805 pounds; field adjoining—depth, 8 inches; yield, 7 tons 567 pounds."

"Depth of plowing, 5 inches; yield per acre, 4 tons 1,633 pounds; field adjoining—depth 10 inches; yield, 14 tons 1,227 pounds."

The fields were adjoining, of equal soil, and received, after plowing, equal care and attention.

The times for plowing vary according to the season, and experience is the only reliable guide. Two plowings are usually given, one deep and one shallow, together with sufficient cultivatings, harrowings and rollings to thoroughly pulverize the soil.

SOWING.

In the State of Michigan the sowing is done not later than May 15, if the ground is in good condition. When the ground reaches 50° F. it is safe to plant beets—some days before it would be safe to plant corn. It is important to secure an early start for sugar beets, so that the tap roots may secure a good hold on the soil before there is danger of dry weather. The beet will stand frost without injury that would kill corn. At Grand Island, Nebraska, the sowing is done about the same time that corn is planted.

Almost any garden drill can be adopted to use with beet seed. A special drill for sugar beet seed is furnished by the Deere-Mansaur Company, of Moline, Illinois.

Drill the seeds one inch deep, in rows eighteen inches apart, making straight for ease in cultivating. In the East the ground is rolled after seeding to insure good contact of the seed with the soil, and thus promote early germination. In Germany the rows are fourteen inches apart, but the cultivation is largely by hand labor,

SEED PER ACRE.

Dr. H. W. Wiley says in planting the beets may be placed in hills, several seeds being planted in each hill, and thus the cultivation of the beets facilitated. In planting by drill it is necessary to plant from 15 to 20 pounds of seed per acre; in planting by hand from 10 to 15 pounds will be found sufficient.

In Europe 20 to 30 pounds per acre are sown. The Oxnard Company uses about twenty pounds of seed to sow an acre.

The Western Beet Sugar Company in the Pajaro Valley, Cala., sow from four to six pounds of seed per acre for bottom lands, and from two and one-half to four for mesa or hill lands, and if carefully sown and the land is in proper condition, a stand good enough for practical purposes will be secured. The average used throughout the valley last year was six and one-half pounds and the tendency is to sow still less.

THINNING AND CULTIVATING.

As soon as the rows of beets are plainly visible, start the cultivator, not only to keep down all weeds, but to keep the surface of the soil open and porous. It is very important to secure and maintain a vigorous growth during the early period of plant life. When the beets put forth the fourth leaf and the root has about the diameter of a wheat straw, the plants should be thinned out to one plant in a place and about six to eight inches apart in a row. This thinning to a single plant is indispensible, for if two or more plants are left together the result will be ill-shaped and imperfectly developed beets of no value for making sugar.

A single beet in a place will secure a root of good conical form; without side roots, about thirteen inches long and weighing from one to two pounds each. This is the beet wanted. The beets should be hoed three times, and if the beet rises above the ground it should be hilled up at each hoeing, because the part that ripens above the ground is of no value for making sugar. When the leaves cover the ground and the crop has taken possession of the field, cultivation should stop, and the plants given time to ripen and develop the saccharine matter. If cultivation is prolonged and vegetable growth too much stimulated, the sugar production may be diminished.

Sugar beets should not be attended to only when the other work of the farm is done and there is nothing else to do, but should be worked when they need working.

EXPENSE OF GROWING AND HARVESTING A BEET CROP.

With reference to what is being done in California in the way of beet culture for sugar purposes, it was learned that last year in the vicinity of Watsonville the yield was 14,000 tons, bringing to the planter an average of $5 04 per ton.

It costs fifteen cents per ton to plow up, forty cents a ton to load and from fifty to seventy-five cents a ton to haul a distance of two and a half miles. It costs about $29 to harvest an acre, which yields a crop valued at $110, so that the planter gains $81 for planting and thinning. One man, residing three miles from the factory, gives the following as the result of the cultivation of a ten-acre field:

Plowing	$50 00
Thinning	190 00
Topping	153 00
Hauling	150 00
Total	$543 00
Yield, tons, 154—value	$972 00
Outlay	543 00
Profit	$429 00
Profit per acre	$42 90

In the Pajaro Valley, California, where labor commands $1 50 to $2 per day, the average cost per acre of the different operations for 1889 was:

Plowing, preparing and sowing	$5 00
Labor, at $1 50 per ton for thinning, weeding, topping and loading into wagon	22 50
Plowing out at 10 cents per ton	1 50
Hauling at 50 cents per ton	7 50
Rent	12 50
Incidental expenses	1 00
Total per acre	$50 00

The average yield of bottom lands in this valley is fifteen tons per acre, and the average price paid by the factory is $5 00 per ton. Assuming this yield, the profit would be $25 00. The factory pays for beets according to their richness; a minimum price of $4 00 per ton is paid up to fourteen per cent of sugar, and fifty cents per ton in addition for each degree of polarization above fourteen per cent. This advantage is practically a premium on good farming.

The following is last year's record of a twenty-acre patch, one and one-half miles from the factory, sown the second week in May (after the last spring rains had fallen) with five pounds of seed per acre, rows twenty inches apart, thinned out second week in June, harvested in October:

"Yield of beets, 405 tons 160 pounds, or 20 tons 508 pounds per acre; yield of sugar, 58 tons 667 pounds, or 2 tons 1,833 pounds per acre. Returns, $1,810 05, or $90 50 per acre, or $4 50 per ton."

The expenses were:

Value of rent of ground	Per acre,	$15 00
Plowing, preparing the land and sowing	" "	5 00
Thinning, hoeing and cultivating	" "	4 50
Plowing out at 10 cents per ton	" "	2 00
Topping at 65 cents per ton	" "	13 00
Hauling at 50 cents per ton	" "	10 00
Total expense	Per acre,	$49 50
Net profit	" "	$41 00

These beets were planted in a two-year-old orchard, and in addition to the above named profit, the young trees were benefitted by the use of the land, and also by the stirring incidental to the cultivation of the beets.

The shape of the sugar beet has much to do with its value as a sugar producing plant. A smooth and symmetrical exterior permits the beet to be easily harvested and washed. An irregularly shaped beet may easily carry into the cutters sand and earth, and even stones of considerable size, quickly dulling and even breaking the knives of the slicing machine. In selecting mothers, therefore, only beets of smooth and symmetrical exteriors are chosen.

If our soil and climate prove favorable, a consideration of this farming problem containing the factor of $16,000,000 paid to one foreign country in one year, may prove of financial gain to our farmers. Doubtless it will be best not to expect too much the first year or two. In Europe it has taken time to educate those who engaged in sugar beet raising, especially in some of the details. The history of beet-sugar factories in Europe has to some extent been one of failure. And in the United States this has been the verdict in the majority of cases. From what has been done in Europe and the United States it will doubtless pay Nevada farmers to experiment—within reasonable and moderate limits on the start—to find out the quality and quantity of sugar beets that they can raise and at what cost.

UNIVERSITY OF NEVADA.

Agricultural * Experiment * Station.

BULLETIN NO. 13.

SUGAR BEET EXPERIMENTS.

Reno, Nevada, October, 1891.

UNIVERSITY OF NEVADA.

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N. E. Wilson, B. S	Chemist
H. P. Brown	Foreman of Farm

SUGAR BEET EXPERIMENTS.

[redacted]Y R. H. McDowell and N. E. Wilson.

The experiments with sugar beets at the Station grounds for the past season consisted of five quarter-acre plats, with an additional eighth of an acre drilled July 1, to test late planting. The plats were lettered from B on the west (plat A planted in potatoes), to and including G on the east and separated by a walk four feet wide.

The following kinds of seed were used: Dippe's Klein Wanzlebener, Vilmorin's Improved, from U. S. Department of Agriculture; Desprez, from Grand Island, Nebraska; Improved Klein Wanzlebener and Betterave a Collet Rouge, from Watsonville, California.

The plats have a general slope to the east—being on the first rise of ground from the Truckee—approximately four hundred feet north and forty feet above the river. The beets occupied the central portion of the grounds between the reduction works and prison wall.

The soil is sandy,—gravel—with a very small quantity of clay. The chances are that very many farmers in the State have a much better soil for farming operations. The ground occupied by sugar beets was sage-brush land, very rocky, broken for the first time in May, 1890, and was used for a variety of vegetables for the season. It was manured at the rate of thirty-five two-horse loads per acre (this is indefinite, but not having hay scales the load measurement was used) and plowed in February, 1891, twelve inches deep.

Before sowing the ground was well harrowed and run over with a "smoother," the latter doing similar work to a roller.

The first sowing of the season was done May 4, by hand, running out the light furrows and covering with a hoe. This sowing was ten rows each of Dippe's Klein Wanzlebener and Vilmorin's improved, seed from U. S. Department of Agriculture. These twenty rows gave a rather better stand of beets than any sown later, possibly on account of the ground being fairly moist from more than usual amount of rain.

SEEDING.

With all the plats the seeding was practically 13 pounds per acre, 1¼ inches deep (drilled excepting 20 rows sown by hand on May 4), with the exception of plats F and G, these were drilled at the rate of 6 pounds per acre. The seed seemed good and resulted in a fair stand —not as good as May 4 seeding.

Although this amount of seed is fully up to the average amount used in California (2½ to 6 pounds per acre, Bulletin Western Beet Sugar Co., page 6.) 10 to 12 pounds per acre is doubtless safer than 6. If the farmer is satisfied from trial that 4 or 6 pounds is sufficient for a solid stand, that is all that is necessary. The width between rows with all plats was 20 inches.

CULTIVATION.

The beets were cultivated June 2, 22, July 20, August 8 and September 3, with sufficient hoeing and weeding to keep the crop clean. The 20 inch rows were found to be narrow for horse cultivation to satisfaction. This particular point of rows and cultivation will receive further attention.

THINNING.

The thinning was started when the beets had four leaves and followed as rapidly as the force employed, and other work, would permit. As near as possible the distance was made 4½ inches. This distance is at variance with the suggestions of the experts. But at the same time one and all objected to the large beet. It is well known to those who have raised root crops in quantity for stock, that with good soil, fair cultivation and liberal space, each plant will be large. To avoid this large plant the space named was used. From this year's trial it would seem best to use at least a 6-inch space between plants and always thin to a single plant in a place.

IRRIGATION.

Light furrows were made between the rows for irrigation, which began June 18, followed with irrigations on June 27, July 5, 11, 18, 29, August 4, 13, 25, and September 3. This will seem like a large amount of irrigation to some of our Nevada growers, but with our sand and gravel soil, and large amount of sunshine, it seemed doubtful whether the beets could be kept growing with a less amount of water. Beets all came up without irrigation.

The following notes on size of beets and leaves were taken August 25, 1891:

VARIETIES OF BEETS.	Date of sowing.	Date up.	Average diameter of beets.	Average length of leaf.	Average width of leaf.
German Beet, Dippe's Klein Wanzlebener	May 4	May 18	2.57	11.55	3.61
French Sugar, Vilmorin's Improved	May 4	May 18	2.17	10.31	3.95
French Sugar, Vilmorin's Improved	May 18	May 30	2.06	9.72	4.
Desprez	May 18	May 30	2.52	9.87	4.2
Desprez	May 19	May 30	2.5	9.75	3.97
Dippe's Klein Wanzlebener	May 19	May 30	2.19	9.27	3.89
Betterave a Collet Rouge	May 26	June 4	1.92	9.37	3.40
Improved Klein Wanzlebener	May 27	June 10	2.11	10.27	4.2
Improved Klein Wanzlebener	July 1	July 9	1.02	9.2	4.1

HARVESTING.

Harvesting was done October 24 and 26. The beets were pulled and thrown in piles with a covering of straw till the topping could be done.

The cultivation and harvesting for this season was hand labor. This is not advocated as being desirable, and one of the points for future prospecting will be in the line of narrow rows, horse cultivation and as much harvesting by horse power as possible.

The following table gives estimates by Dr. Wiley, based on samples of beets sent; weight and number of beets per row :

VARIETIES OF BEETS.	Sown........	How sown.....	Seed per acre..	Sampled for Washington..	Tons per acre.	Probable yield of Sugar per acre, lbs.....
Vilmorin's Improved..........	May 4..	By hand..	13 lbs.	Oct. 19	14.6	4,709
Dippe's Klein Wanzlebener..	May 4..	By hand..	13 lbs.	Oct. 19	12.4	3,968
Dippe's Klein Wanzlebener..	May 19.	Drilled ...	13 lbs.	Oct. 19	7.8	2,735
Desprez..........................	May 18.	Drilled ...	13 lbs.	Oct. 19	6.1	1,770
Improv'd Klein Wanzlebener.	May 27.	Drilled ...	6 lbs.	Oct. 19	5.9	1,486
Betterave a Collet Rouge.......	May 26.	Drilled ...	13 lbs.	Oct. 19	5.9	1,317
Improv'd Klein Wanzlebener.	July 1..	Drilled ...	6 lbs.	Oct. 19	3.	811

Nine rows 111 feet long of Dippe's Klein Wanzlebener sown May 4 weighed 1,094 pounds. The same number and length of rows of Vilmorin's Improved sown May 4 weighed 923 pounds.

Dr. Wiley gives the tonnage per acre (second set of samples), of the Dippe's Klein Wanzlebener, planted May 4, pulled about November 12, as 16.3.

Not having a sufficient number of "directions" for taking beet samples to send to all who received beet seed, a specimen sheet is given.

UNITED STATES DEPARTMENT OF AGRICULTURE.
WASHINGTON, D. C., July 1, 1891.

DIRECTIONS FOR TAKING SAMPLES OF SUGAR BEETS FOR ANALYSIS.

When the beets appear to mature (September 15 to November 15, according to latitude and time of planting), and before any second growth can take place, select an average row and gather every plant along a distance which should vary as follows, according to the width between rows:

From rows 16 inches apart gather 75 feet.
" " 18 " " " 66 and two-thirds feet.
" " 20 " " " 59 and four-fifths "
" " 22 " " " 54 and three-fifths "
" " 24 " " " 50 "

The number of beets growing in the row, of the length above mentioned, must be counted. The tops are then to be removed, the beets carefully washed free of all dirt, wiped with a towel and weighed. Where the row is not long enough to meet the conditions take enough from the adjacent row or rows to make up the required length. The number of beets harvested multiplied by 435.6 will give the total number per acre. The total weight of beets harvested multiplied by 435.6 will give the yield per acre.

Rows of average excellence must be selected; avoid the best or poorest. Throw the beets promiscuously in a pile and divide the pile into two parts. This subdivision may be continued until there are about ten beets in a pile. Of these ten select two of medium size. Be careful not to select the largest or smallest. Wrap the beets carefully in paper and put your name thereon. Sew the beets up in a cotton bag, attach the enclosed shipping tag thereto, and send by mail.

Fill out blank describing beet, enclose in the envelope and sew up in bag with beets.

No beets will be analyzed which are not sampled as described above and properly identified.

Miscellaneous analyses of samples without accurate description are of no value.

It is but just to the farmer and the Department that samples should be taken with the precautions required.

Blanks are sent to each one for two sets of samples. From two to four weeks should elapse between the times of sending the two sets of samples.

If additional analyses are required other blanks will be sent on application, but not more than four analyses can be made for any one person, except in special cases. W. H. WILEY, *Chemist.*

COST PER ACRE.

It will be noticed in the answers given to questions by Mr. Springmeyer, that he gives the cost of raising an acre of beets at $35. The cost per acre at the Station will exceed this fully $15. This is accounted for in largely using hand labor and more labor; Mr. Springmeyer irrigating three times and cultivating one piece once, another twice.

While at the Station we irrigated ten times and cultivated five times. As elsewhere noted the attempt at the Station will be to use more horse labor. The figures on cost vary largely between different portions of the United States and Europe. In some portions of Europe the cost is given at $70 to $80 per acre, including rent, taxes and fertilizers. Some raisers in Nebraska put the cost per acre at $10 to $13. Some have figured labor in the central east at 10 cents per hour. This will not answer in Nevada.

The following tables show the analytical data of Station beets.

Samples were taken August 31, before beets were near maturity and then at or about time of harvesting in October. The latter analyses show a very considerable gain in sucrose over the first analyses.

TABLE No. 1.

Showing the analyses of samples taken August 31, 1891.

Station No.	VARIETY.	Plat	Planting, time of	Sampling, time of	Weight of samples.		Total solids, per cent of.	Sucrose, per cent of in juice	Purity
					Lbs.	Ozs.			
1	Dippe's Klein Wanzlebener	B	May 4	Aug. 31	------	15	21.10	15.46	73.21
2	Vilmorin's Improved	B	May 4	Aug. 31	------	13	17.28	13.57	78.53
3	Vilmorin's Improved	B	May 18	Aug. 31	------	11	18.40	16.00	86.09
4	Desprez	C	May 18	Aug. 31	------	15	19.46	16.50	84.79
5	Desprez	B	May 19	Aug. 31	------	13	17.32	13.47	77.77
6	Imp'vd Klein Wanzlebener	E	May 27	Aug. 31	------	6	18.91	15.22	79.42
7	Betterave a Collet rouge	F	May 27	Aug. 31	------	5	15.92	12.15	76.32
8	Imp'vd Klein Wanzlebener	E	May 27	Aug. 31	------	10	19.50	14.20	72.87
9	Dippe's Klein Wanzlebener	F	May 19	Aug. 31	------	10	21.58	17.50	81.09
10	Imp'vd Klein Wanzlebener	G	July 1	Aug. 31	------	4	14.91	12.00	80.49

TABLE No. 2.

Showing analyses of samples taken at time of harvesting in October.

Station No.	VARIETY.	Plat	Planting, time of	Sampling, time of	Weight.		Total solids	Sucrose in juice	Purity co-efficient
					Lbs.	Ozs.			
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 9	2	6	19.71	17.00	86.26
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 9	------	8	26.47	22.50	85.31
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 9	------	8	27.40	23.80	86.86
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 19	1	4	19.59	17.20	87.59
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 19	1	4	19.63	18.20	92.73
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 19	------	14	19.02	17.30	93.08
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 19	------	12	21.46	20.20	94.13
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 19	------	9	21.17	20.50	96.82
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 19	------	6	21.14	19.50	97.55
[illegible]	Dippe's Klein Wanzlebener	B	May 4	Oct. 28	1	7	23.29	21.00	88.13
[illegible]	Dippe's Klein Wanzlebener	F	May 19	Oct. 24	------	13	18.35	16.90	92.09
[illegible]	Dippe's Klein Wanzlebener	F	May 19	Oct. 24	1	11	24.25	20.10	90.75
[illegible]	Vilmorin's Improved------	B	May 4	Oct. 19	2	1	16.42	15.10	96.38
[illegible]	Vilmorin's Improved------	B	May 4	Oct. 19	1	4	19.39	17.40	89.76
[illegible]	Vilmorin's Improved------	B	May 4	Oct. 19	1	3	20.08	18.50	92.22
[illegible]	Vilmorin's Improved------	B	May 4	Oct. 19	------	13	19.77	18.90	93.42
[illegible]	Vilmorin's Improved------	B	May 4	Oct. 19	------	9	19.88	17.40	87.53
[illegible]	Vilmorin's Improved------	B	May 4	Oct. 19	------	8	21.89	20.10	91.83
[illegible]	Desprez ------------------	C	May 18	Oct. 20	------	10	23.60	22.00	94.07
[illegible]	Desprez ------------------	C	May 18	Oct. 20	------	12	22.37	18.60	85.07
[illegible]	Desprez ------------------	C	May 18	Oct. 20	------	14	22.16	21.10	95.26
[illegible]	Desprez ------------------	C	May 18	Oct. 20	------	10	23.65	18.20	76.97
[illegible]	Desprez ------------------	C	May 18	Oct. 20	------	8	23.87	21.90	91.72
[illegible]	Desprez ------------------	C	May 18	Oct. 20	------	5	22.30	21.40	98.19
[illegible]	Desprez ------------------	C	May 18	Oct. 23	1	2	20.78	19.90	95.75
[illegible]	Desprez ------------------	C	May 18	Oct. 23	1	1	18.44	16.40	88.94
[illegible]	Desprez ------------------	C	May 18	Oct. 23	------	13	22.10	19.10	86.41
[illegible]	Desprez ------------------	C	May 18	Oct. 23	------	11	21.95	20.10	91.56
[illegible]	Desprez ------------------	C	May 18	Oct. 23	1	8	23.20	20.80	87.61
[illegible]	Desprez ------------------	C	May 18	Oct. 23	1	11	24.25	21.10	91.56
[illegible]	Desprez ------------------	B	May 19	Oct. 20	------	9	20.98	18.50	88.19
[illegible]	Desprez ------------------	B	May 19	Oct. 20	3	14	22.48	21.60	96.12
[illegible]	Desprez ------------------	B	May 19	Oct. 20	------	14	22.68	21.90	94.36
[illegible]	Desprez ------------------	B	May 19	Oct. 20	------	9	22.51	20.80	95.55
[illegible]	Desprez ------------------	B	May 19	Oct. 20	------	8	22.68	21.20	93.47
[illegible]	Desprez ------------------	B	May 19	Oct. 20	------	9	22.12	21.20	95.87
[illegible]	Desprez ------------------	B	May 19	Oct. 24	2	12	19.80	17.20	86.88
[illegible]	Desprez ------------------	B	May 19	Oct. 24	2	14	20.02	17.60	87.91
[illegible]	Imp. Klein Wanzlebener--	E	May 27	Oct. 24	1	------	19.26	18.00	93.40
[illegible]	Imp. Klein Wanzlebener--	E	May 27	Oct. 24	1	8	20.09	17.90	89.09
[illegible]	Imp. Klein Wanzlebener--	E	May 27	Oct. 24	1	2	21.19	15.90	75.03
[illegible]	Imp. Klein Wanzlebener--	E	May 27	Oct. 24	------	13	19.97	16.70	83.62
[illegible]	Imp. Klein Wanzlebener--	E	May 27	Oct. 24	------	8	21.76	17.10	78.58
[illegible]	Imp. Klein Wanzlebener--	E	May 27	Oct. 24	------	8	23.32	21.70	93.43
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 20	------	12	17.21	16.40	97.55
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 20	------	11	17.91	14.20	79.31
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 20	------	9	14.64	12.80	87.67
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 20	------	15	15.76	13.90	88.02
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 20	------	10	17.20	14.90	86.62
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 20	------	8	17.54	16.30	92.93
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 22	------	15	16.78	16.30	97.10
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 22	------	14	15.92	14.90	93.59
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 22	------	8	18.70	16.60	88.85
[illegible]	Betterave a Collet rouge---	F	May 27	Oct. 22	------	9	19.52	17.90	91.49
[illegible]	Imp. Klein Wanzlebener--	G	July 1	Oct. 23	------	8	16.94	15.90	98.34
[illegible]	Imp. Klein Wanzlebener--	G	July 1	Oct. 23	------	6	13.89	12.70	91.53
[illegible]	Imp. Klein Wanzlebener--	G	July 1	Oct. 23	------	5	17.35	15.60	71.41
[illegible]	Imp. Klein Wanzlebener--	G	July 1	Oct. 23	------	6	19.24	16.10	81.71

TABLE No. 3.

Showing average analyses of different varieties grown on Station Farm.

VARIETY.	Solids.	Sucrose.	Purity,
Dippe's Klein Wanzlebener	21.79	19.41	89.07
Vilmorin's Improved	19.57	17.90	91.46
Desprez, May 18	22.39	20.05	89.54
Desprez, May 19	21.66	20.00	92.33
Improved Klein Wanzlebener	20.93	17.88	85.42
Betterave a Collet rouge	17.12	15.42	90.07
Improved Klein Wanzlebener, July 1	16.18	15.07	93.13

TABLE No. 4.

Showing analyses by Dr. H. W. Wiley, Chemist to United States Department of Agriculture, of samples rom Station Farm.

VARIETY.	Sucrose.	Purity.
Dippe's Klein Wanzlebener, May 4	20.00	87.50
Vilmorin's Improved	20.20	94.10
Desprez	19.20	87.20
Dippe's Klein Wanzlebener, May 19	22.00	93.00
Improved Klein Wanzlebener	17.00	86.40
Betterave a Collet rouge	15.80	82.40

The following meteorological summary by Mr. W. E. Barney shows climatic conditions under which the Station beets were grown:

TEMPERATURE.	May.	June.	July.	Aug.*	Sept.	Oct.
Highest temperature	77.0	89.6	95.0	96.0	92.0	77.3
Lowest temperature	30.0	32.5	38.0	37.0	31.0	25.3
Mean temperature	53.6	59.2	68.4	71.2	59.1	51.6
Total precipitation	2.73	0.41	trace	trace	0.54	trace
Number of cloudy days	8	6	0	1	7	2
Number of days on which .01 inches or more of rain fell	14	8	0	0	6	0
First frost	--------	--------	--------	--------	Sept. 24	--------

BEETS FROM THE STATE AT LARGE.

Aside from the experiments carried on at the Station Farm, a quantity of seed was sent out to individual farmers over the State, with a request that the seed be planted, careful notes be made of growth and cultivation and when crops matured, samples be sent to the Station for analysis.

Quite a number undertook the work, but we have not received returns from all as we desired. While some of the samples sent in were not accompanied by complete data as to soil, culture, etc., it was thought best to analyze all beets sent in, since the analyses would show in general, as far as sugar content is concerned, with what results sugar beets can be grown in Nevada, which, indeed, is the prime object of this season's experiments.

The results of these analyses are shown in Table 3, which is a general summary of all analyses made this season. We have endeavored to make the tabulation as complete as possible, but being unable to obtain full notes in all cases were obliged to leave some space vacant.

Table No. 5.

General summary of all analyses.

Station No.	Grower.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
1	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Aug. 31	Sandy, gravel, small am't clay
2	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Aug. 31	Sandy, gravel, small am't clay
3	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 18	Aug. 31	Sandy, gravel, small am't clay
4	Station Farm	Reno, Washoe county	Desprez	May 18	Aug. 31	Sandy, gravel, small am't clay
5	Station Farm	Reno, Washoe county	Desprez	May 19	Aug. 31	Sandy, gravel, small am't clay
6	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Aug. 31	Sandy, gravel, small am't clay
7	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Aug. 31	Sandy, gravel, small am't clay
8	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Aug. 31	Sandy, gravel, small am,t clay
9	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 19	Aug. 31	Sandy, gravel, small am't clay
10	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Aug. 31	Sandy, gravel, small am't clay
11	Orrin Ross	Reno, Washoe county	Dippe's Klein Wanzlebener	May 15	Sep. 10	Alkali
12	Orrin Ross	Reno, Washoe county	Dippe's Klein Wanzlebener	May 15	Sep. 10	Alkali
13	Orrin Ross	Reno, Washoe county	Vilmorin's Improved	May 15	Sep. 10	Loam
14	Orrin Ross	Reno, Washoe county	Vilmorin's Improved	May 15	Sep. 10	Loam
15	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	June 3	Sep. 20	Bottom land
16	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	June 3	Sep. 20	Bottom land
17	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	June 3	Sep. 20	Bottom land
18	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	New sagebrush land
19	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	New sagebrush land
20	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	New sagebrush land
21	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	Clay land
22	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	Clay land
23	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	Clay land
24	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	Alkali
25	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	Alkali
26	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 11	Sep. 20	Alkali
39	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Sep. 29	Sandy loam, gravel and clay
40	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	Alkali
41	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	Alkali
42	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	Alkali
43	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	Alkali

TABLE No. 5—Continued.

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
1	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	15	21.10	15.46	73.21
2	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	13	17.28	13.57	78.53
3	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	11	18.40	16.00	86.09
4	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	15	19.46	16.50	84.79
5	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	13	17.32	13.47	77.77
6	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	6	18.91	15.22	79.42
7	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	5	15.92	12.15	76.32
8	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	10	19.50	14.20	72.87
9	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	10	21.58	17.50	81.09
10	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	*	4	14.91	12.00	80.49
11	Cultivated every week for 4 weeks, weeds pulled about last of August	2	12	11.19	7.00	62.00
12	Cultivated every week for 4 weeks, weeds pulled about last of August		9	14.80	12.00	81.00
13	Cultivated every week for 4 weeks, weeds pulled about last of August	1	14	14.25	12.00	84.00
14	Cultivated every week for 4 weeks, weeds pulled about last of August		11	15.42	14.00	85.00
15	Cultivated with horse twice, hoed once, irrigated 3 times	8	4	14.65	5.50	75.56
16	Cultivated with horse twice, hoed once, irrigated 3 times	1	9	13.42	11.50	85.70
17	Cultivated with horse twice, hoed once, irrigated 3 times		9	14.66	11.50	71.90
18	Cultivated with horse once, hoed once, irrigated 3 times	4	3	13.66	6.00	43.92
19	Cultivated with horse once, hoed once, irrigated 3 times	3	2	21.82	13.25	60.72
20	Cultivated with horse once, hoed once, irrigated 3 times	1	15	10 67	9.00	84.35
21	Cultivated with horse once, hoed once, irrigated 3 times		12	18.04	15.25	84.53
22	Cultivated with horse once, hoed once, irrigated 3 times	1	1	14.99	12.10	80.73
23	Cultivated with horse once, hoed once, irrigated 3 times	3	4	16.08	14.75	91.74
24	Cultivated with horse once, hoed once, irrigated 3 times	2	13	13.25	12.30	92.84
25	Cultivated with horse once, hoed once, irrigated 3 times	1	3	14.12	11.20	81.17
26	Cultivated with horse once, hoed once, irrigated 3 times		14	18.57	15.75	86.82
39	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	1	7	16.19	13.60	84.00
40		2	6	13.20	11.20	84.09
41		2	6	12.73	8.80	69.12
42	Cultivated	2	1	14.30	13.50	94.00
43	Cultivated	4	10	11.64	8.00	68.71

* Average of 6 beets.

TABLE No. 5—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
44	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	May 12	Oct. 1	Alkali
45	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	Alkali
46	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	May 12	Oct. 1	Foothill and black alkali
47	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 12	Oct. 1	Foothill and black alkali
48	E. T. George	Lewis, Lander county	Vilmorin's Improved	May 12	Oct. 1	Foothill and black alkali
49	E. T. George	Lewis, Lander county	Betterave a Collet Rouge	May 12	Oct. 1	Foothill and black alkali
50	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 12	Aug. 19	Foothill and black alkali
51	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	May 12	Aug. 19	Foothill and black alkali
52	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	Alkali
53	A. G. Brown	Brown's Station, Washoe Co	Betterave a Collet rouge	May 24	Oct. 5	Sandy loam
54	A. G. Brown	Brown's Station, Washoe Co	Betterave a Collet rouge	May 24	Oct. 5	Sandy loam
55	A. G. Brown	Brown's Station, Washoe Co	Betterave a Collet rouge	May 24	Oct. 5	Sandy loam
56	E. E. Crane	Steamb't Springs, Washoe Co	Betterave a Collet rouge	May 28	Sep. 25	
57	E. E. Crane	Steamb't Springs, Washoe Co	Betterave a Collet rouge	May 28	Sep. 25	
58	E. E. Crane	Steamb't Springs, Washoe Co	Betterave a Collet rouge	May 28	Sep. 25	
59	E. E. Crane	Steamb't Springs, Washoe Co	Betterave a Collet rouge	May 28	Sep. 25	Alkali
60	E. E. Crane	Steamb't Springs, Washoe Co	Betterave a Collet rouge	May 28	Sep. 25	Alkali
61	E. E. Crane	Steamb't Springs, Washoe Co	Betterave a Collet rouge	May 28	Sep. 25	Alkali
62	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 12	Oct. 3	Alkali, with sandy loam
63	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 12	Oct. 3	Alkali, with sandy loam
64	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 12	Oct. 3	Alkali, with sandy loam
65	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanslebener	May 5	Oct. 3	Alkali, with sandy loam
66	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 5	Oct. 3	Alkali, with sandy loam
67	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 5	Oct. 3	Alkali, with sandy loam
68	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
69	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
70	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
71	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
72	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
73	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
74	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			
75	G. W. Crumb	Battle Mountain, Lander Co.	Unknown			Alkali, new land

TABLE No. 5 Continued.

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
44	Cultivated	1	0	14.31	10.20	71.27
45	Hoed twice	1	13	15.85	12.50	72.55
46	Hoed twice	1	2	24.72	20.90	82.91
47	Hoed twice	1	10	22.05	19.60	88.88
48	Hoed twice	1	2	23.04	20.20	87.63
49	Hoed twice		4	23.56	19.00	80.64
50	Hoed twice		12	* 24.91	21.80	87.09
51	Hoed twice		9	* 33.80	26.20	77.51
52	Hoed twice	4	14	15.09	8.20	54.34
53	Irrigated once a week	4	1	11.94	9.80	86.03
54	Irrigated once a week	3	6	12.06	8.90	73.79
55	Irrigated once a week	1	9	13.05	10.00	76.62
56	Irrigated once a week	1	0	14.11	11.60	82.21
57	Irrigated once a week	1	4	12.93	10.70	82.75
58	Irrigated once a week		12	13.62	10.70	78.41
59	Irrigated once a week	1	5	12.12	7.30	60.23
60	Irrigated once a week	1	3	17.37	14.60	84.05
61	Irrigated once a week	1	5	9.34	5.50	58.36
62	Irrigated once in 10 days	1	7	13.78	10.00	72.55
63	Irrigated once in 10 days	2	12	14.14	10.60	74.96
64	Irrigated once in 10 days	2	1	13.71	11.50	83.87
65	Irrigated once in 10 days	1	12	13.15	10.70	80.68
66	Irrigated once in 10 days	1	2	12.43	8.60	69.18
67	Irrigated once in 10 days	6	6	9.43	8.00	84.83
68		2	8	13.66	9.70	71.01
69		4	13	12.97	8.80	67.80
70		2	6	14.03	10.20	72.70
71		2	4	14.59	10.20	69.99
72		1	4	13.53	10.00	73.99
73		1	5	10.80	7.80	72.22
74		2	11	16.26	12.40	76.38
75	Not cultivated; not irrigated	3	6	13.24	11.10	84.59

* These two beets, Nos. 50 and 51, were pulled Aug. 19th and brought to Station for analysis Oct. 5th. During this time they lost in weight 8 and 6 ounces respectively. This accounts for high sugar percentage.

TABLE No. 5—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
76	G. W. Crumb	Battle Mountain, Lander Co.	Unknown			Alkali, new land
77	G. W. Crumb	Battle Mountain, Lander Co.	Unknown			Alkali, new land
78	G. W. Crumb	Battle Mountain, Lander Co.	Unknown			Alkali, new land
79	G. W. Crumb	Battle Mountain, Lander Co.	Unknown			Alkali, new land
80	G. W. Crumb	Battle Mountain, Lander Co.	Unknown			Alkali, new land
81	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Alkali soil
82	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Alkali soil
83	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Alkali soil
84	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Sandy loam
85	D. C. Simpson	Wellington. Lyon county	Improved Klien Wanzlebener			Sandy loam
86	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Sandy loam
87	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Gravely soil
88	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Gravely soil
89	D. C. Simpson	Wellington, Lyon county	Improved Klien Wanzlebener			Gravely soil
90	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klien Wanzlebener			Alkali
91	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klien Wanzlebener			Alkali
92	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klien Wanzlebener			Alkali
93	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klien Wanzlebener			Alkali
94	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klien Wanzlebener			Alkali
95	Chas. Ross	Mason Valley, Lpon county	Verbesseter Klien Wanzlebener			Alkali
96	R. Lewers	Franktown, Washoe county	Verbesseter Klien Wanzlebener	May 1	Oct. 11	Sandy loam
97	R. Lewers	Franktown, Washoe county	Verbesseter Klien Wanzlebener	May 1	Oct. 11	Sandy loam
98	R. Lewers	Franktown, Washoe county	Verbesseter Klien Wanzlebener	May 1	Oct. 11	Sandy loam
99	Station Farm	Reno, Washoe county	Dippe's Klien Wanzlebener	May 4	Oct. 9	Sandy, with gravel and clay
100	Station Farm	Reno, Washoe county	Dippe's Klien Wanzlebener	May 4	Oct. 9	Sandy, with gravel and clay
101	Station Farm	Reno, Washoe county	Dippe's Klien Wanzlebener	May 4	Oct. 9	Sandy, with gravel and clay
102	Robt. Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	Sandy loam
103	Robt. Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	Sandy loam
104	Robt. Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	Sandy loam
105	Robt. Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	Sandy loam
106	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
107	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam

TABLE NO. 5. *Continued.*

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
76	Not cultivated; not irrigated	2	8	15.28	12.10	79.18
77	Not cultivated; not irrigated	2	2	14.35	13.30	92.68
78	Not cultivated; not irrigated	1	13	15.32	13.40	87.46
79	Not cultivated; not irrigated	3	12	11.65	8.80	75.53
80	Not cultivated; not irrigated	1	15	12.99	9.40	72.36
81			7	19.77	17.50	88.51
82		1	0	18.49	15.20	81.99
83		2	6	13.36	11.90	89.07
84		2	2	13.73	10.50	76.40
85		1	6	14.99	10.00	66.63
86		3	12	12.85	11.40	88.72
87		3	5	15.03	12.30	81.82
88			6	16.82	15.20	90.37
89		1	8	16.26	14.10	88.74
90		2	7	16.19	12.50	77.20
91		6	7	12.77	7.90	61.86
92		5	3	10.79	7.60	70.43
93		6	13	12.50	9.00	72.00
94		7	8	18.64	6.30	33.97
95		3	12	15.43	13.60	88.13
96	Ordinary garden cultivation		14	22.84	17.50	76.66
97	Ordinary garden cultivation	1	6	17.29	14.70	85.01
98	Ordinary garden cultivation		12	17.58	15.40	87.03
99	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times	2	6	19.71	17.00	86.26
100	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		8	26.47	22.50	85.31
101	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		8	27.40	23.80	86.86
102	Cultivated once, hoed once and irrigated twice	1	12	12.88	11.10	86.97
103	Cultivated once, hoed once and irrigated twice	1	12	14.35	12.30	85.71
104	Cultivated once, hoed once and irrigated twice	1	15	16.99	13.90	81.81
105	Cultivated once, hoed once and irrigated twice	1	7	17.58	14.20	80.77
106	Irrigated	3	12	14.90	9.90	60.40
107	Irrigated	2	14	11.24	8.00	71.17

TABLE No. 5- -*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
108	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
109	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
110	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
111	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
112	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
113	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	Sandy loam
114	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	Sandy, with gravel and clay
115	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	Sandy, with gravel and clay
116	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	Sandy, with gravel and clay
117	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	Sandy, with gravel and clay
118	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	Sandy, with gravel and clay
119	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	Sandy, with gravel and clay
120	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	Sandy, with gravel and clay
121	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	Sandy, with gravel and clay
122	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	Sandy, with gravel and clay
123	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	Sandy, with gravel and clay
124	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	Sandy, with gravel and clay
125	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	Sandy, with gravel and clay
126	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20	Sandy, with gravel and clay
127	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20	Sandy, with gravel and clay
128	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20	Sandy, with gravel and clay
129	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20	Sandy, with gravel and clay
130	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20	Sandy, with gravel and clay
131	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20	Sandy, with gravel and clay
132	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20	Sandy, with gravel and clay
133	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20	Sandy, with gravel and clay
134	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20	Sandy, with gravel and clay
135	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20	Sandy, with gravel and clay
136	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20	Sandy, with gravel and clay
137	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20	Sandy, with gravel and clay
138	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20	Sandy, with gravel and clay
139	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20	Sandy, with gravel and clay

TABLE No. 5—Continued.

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
108	Irrigated	2		14.00	13.00	84.57
109	Irrigated	1	12	14.53	12.50	83.27
110	Irrigated	1	2	15.05	11.60	77.07
111	Transplanted in May; irrigated	1	5	15.58	13.20	84.85
112	Transplanted in May; irrigated	1	5	17.52	15.00	83.35
113	Transplanted in May; irrigated	1	2	20.44	18.60	90.95
114	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times	2	1	16.42	15.10	96.38
115	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times	1	4	19.39	17.40	89.76
116	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times	1	3	20.08	18.50	92.22
117	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		13	19.77	18.90	93.42
118	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		9	19.88	17.40	87.53
119	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		8	21.89	20.10	91.83
120	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times	1	4	19.59	17.20	87.50
121	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times	1	4	19.63	18.20	92.73
122	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		14	19.02	17.30	93.08
123	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		12	21.46	20.20	94.13
124	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		9	21.17	20.50	96.82
125	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		6	21.14	19.50	92.56
126	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		12	17.21	16.40	97.55
127	Cultivated 5 timds, hoed sufficient to keep down weeds, irrigated 10 times		11	17.91	14.20	79.31
128	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		9	14.64	12.80	87.67
129	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		15	15.76	13.90	88.02
130	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		10	17.20	14.90	86.62
131	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		8	17.54	16.30	92.93
132	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		9	20.98	18.50	88.19
133	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		14	22.48	21.60	96.12
134	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		14	22.68	21.90	94.36
135	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		9	22.51	20.80	95.55
136	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		8	22.68	21.20	93.47
137	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		9	22.12	21.20	95.87
138	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		10	23.60	22.00	94.07
139	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		12	22.37	18.60	85.07

TABLE NO. 5- -*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
140	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20	Sandy, with gravel and clay
141	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20	Sandy, with gravel and clay
142	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20	Sandy, with gravel and clay
143	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20	Sandy, with gravel and clay
144	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener			
145	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener			
146	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener			
147	F. Dangberg	Genoa, Douglas county				Sandy loam
148	F. Dangberg	Genoa, Douglas county				Sandy loam
149	F. Dangberg	Genoa, Douglas county				Sandy loam
150	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23	Sandy, with gravel and clay
151	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23	Sandy, with gravel and clay
152	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23	Sandy, with gravel and clay
153	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23	Sandy, with gravel and clay
154	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23	Sandy, with gravel and clay
155	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23	Sandy, with gravel and clay
156	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23	Sandy, with gravel and clay
157	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23	Sandy, with gravel and clay
158	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Oct. 23	Sandy, with gravel and clay
159	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Oct. 23	Sandy, with gravel and clay
160	Station Farm	Reno, Washoe connty	Improved Klein Wanzlebener	July 1	Oct. 23	Sandy, with gravel and clay
161	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Oct. 23	Sandy, with gravel and clay
162	D. H. Dillard	St. Clair, Churchill county	Desprez			
163	D. H. Dillard	St. Clair, Churchill county	Desprez			
164	D. H. Dillard	St. Clair, Churchill county	Desprez			
165	D. H. Dillard	St. Clair, Churchill county	Desprez			
166	D. H. Dillard	St. Clair, Churchill county	Desprez			
167	D. H. Dillard	St. Clair, Churchill county	Desprez			
168	D. H. Dillard	St. Clair, Churchill county	Desprez			
169	D. H. Dillard	St. Clair, Churchill county	Desprez			
170	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sandy loam, large amount sand
171	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sandy loam, large amount sand

TABLE No. 5—*Continued.*

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
140	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		14	22.16	21.10	95.26
141	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		10	23.65	18.20	76.97
142	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		8	23.87	21.90	91.72
143	Cultivated 5 times, hoed sufficient to keep down weeds, irrigated 10 times		5	22.30	21.40	98.19
144		1	9	23.51	17.30	74.00
145			14	26.80	21.10	79.04
146			3	24.22	22.00	92.96
147		3	1	15.80	13 20	83.53
148		2	3	14.11	13.70	97.08
149		1	14	12.83	12.60	95.83
150	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		15	16.78	16.30	97.10
151	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		14	15.92	14.90	93.59
152	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		8	18.70	16.60	88.85
153	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		9	19.52	17.90	91.49
154	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	1	2	20.78	19.90	95.75
155	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	1	1	18.44	16.40	88.94
156	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		13	22.10	19.10	86.41
157	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		11	23.20	20.80	87.61
158	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		8	16.94	15.90	98.34
159	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		6	13.89	12.70	91.53
160	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		5	17.35	15.60	71.41
161	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		6	19.24	16.10	81.77
162			12	17.64	16.30	92.41
163			7	21.88	17.80	81.25
164			9	19.74	14.90	75.47
165			10	17.15	15.40	71.16
166			10	20.60	16.10	78.13
167			12	20.05	17.10	85.24
168			14	19.29	17.10	91.17
169			9	19.55	17.20	87.97
170	Cultivated with horse once, hoed once, irrigated 3 times	1	12	14.25	13.10	92.11
171	Cultivated with horse once, hoed once, irrigated 3 times		13	17.17	15.80	91.99

TABLE No. 5—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
172	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sagebrush
173	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sagebrush
174	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sagebrush
175	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sagebrush
176	H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	May 17	Oct. 24	Sagebrush
177	F. Dangberg	Genoa, Douglas county			Oct. 24	Sandy loam, old garden spot
178	F. Dangberg	Genoa, Douglas county			Oct. 24	Sandy loam, old garden spot
179	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20		Clay loam
180	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20		Clay loam
181	J. W. Haines	Genoa, Douglas county			Oct. 17	Upland, gravelly, no irrigation
182	J. W. Haines	Genoa, Douglas county			Oct. 17	Upland, gravelly, no irrigation
183	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	Sandy, with gravel and clry
184	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	Sandy, with gravel and clay
185	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	Sandy, with gravel and clay
186	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	Sandy, with gravel and clay
187	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	Sandy, with gravel and clay
188	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	Sandy, with gravel and clay
189	Station Farm	Reno, Washoe county	Unknown red beet	May 4	Oct. 28	Sandy, with gravel and clay
190	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 28	Sandy, with gravel and clay
191	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20	Oct. 26	Clay loam
192	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20	Oct. 26	Clay loam
193	John Harrison	Lovelocks, Humboldt Co.	Unknown	May 1	Oct. 15	Black loam
194	John Harrison	Lovelocks, Humboldt Co.	Unknown	May 1	Oct. 15	Black loam
195	John Harrison	Lovelocks, Humboldt Co.	Unknown	May 1	Oct. 15	Sandy loam
196	John Harrison	Lovelocks, Humboldt Co.	Unknown	May 1	Oct. 15	Sandy loam
197	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 24	Sandy loam, gravel and clay
198	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 24	Sandy loam, gravel and clay
199	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 19	Oct. 24	Sandy loam, gravel and clay
200	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 24	Sandy loam, gravel and clay
201	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 19	Oct. 24	Sandy loam, gravel and clay
202	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali
203	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali

TABLE No. 5—Continued.

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
172	Cultivated with horse once, hoed once, irrigated 3 times	1	1	16.05	15.70	97.82
173	Cultivated with horse once, hoed once, irrigated 3 times	1	7	16.86	15.50	91.95
174	Cultivated with horse once, hoed once, irrigated 3 times	3	12	23.16	10.20	44.05
175	Cultivated with horse once, hoed once, irrigated 3 times	4	2	16.93	11.90	73.61
176	Cultivated with horse once, hoed once, irrigated 3 times	2	2	15.90	10.70	67.27
177		4	10	10.18	8.10	79.56
178		1	2	14.66	12.10	82.55
179	Cultivated every 2 weeks, irrigated every 10 days	3	2	14.96	11.80	78.88
180	Cultivated every 2 weeks, irrigated every 10 days	2	12	17.90	8.90	49.60
181			5	25.45	21.80	85.64
182			3	24.17	21.00	87.43
183	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	1		19.26	18.00	93.40
184	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	1	8	20.09	17.90	89.09
185	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times	1	2	21.19	15.90	75.03
186	Cultivated 5 times, hoed sufficient to deep weeds ont, irrigated 10 times		13	19.97	16.70	83.62
187	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		8	21.76	17.10	78.58
188	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		8	23.22	21.70	93.43
189	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		6	23.86	22.00	92.23
190	Cultivated 5 times, hoed sufficient to keep weeds out, irrigated 10 times		15	23.29	21.00	88.13
191	Cultivated about every two weeks, irrigated every 10 days	1	7	18.35	16.90	92.09
192	Cultivated about every two weeks, irrigated every 10 days		13	22.72	17.60	77.46
193	Irrigated weekly	1	2	22.24	18.10	81.37
194	Irrigated weekly	1	7	18.19	15.90	87.37
195	Water only once		8	22.59	21.10	94.26
196	Water only once		11	21.66	19.90	91.45
197	Cultivated 5 times, hoed sufficient to keep weeds down, irrigated 10 times	2	12	19.80	17.20	86.88
198	Cultivated 5 times, hoed sufficient to keep weeds down, irrigated 10 times	2	14	20.02	17.60	87.91
199	Cultivated 5 times, hoed sufficient to keep weeds down, irrigated 10 times	1	8	21.95	20.10	91.56
200	Cultivated 5 times, hoed sufficient to keep weeds down, irrigated 10 times	1	11	24.25	21.10	87.03
201	Cultivated 5 times, hoed sufficient to keep weeds down, irrigated 10 times	1	3	22.15	20.10	90.75
202	Irrigated once in 2 weeks, not cultivated	2	7	19.30	9.00	46.63
203	Irrigated once in 2 weeks, not cultivated	1	12	14.91	13.00	87.19

TABLE NO. 5—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Harvesting, Time of	Kind of Soil.
204	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali
205	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali
206	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali
207	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali
208	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	Alkali
209	Orrin Ross	Reno. Washoe county	Dippe's Klein Wanzlebener	May 16	Sep. 21	Alkali
210	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	May 15	Nov. 5	Alkali
211	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	May 15	Nov. 5	Alkali
212	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	May 15	Nov. 5	Alkali
213	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April — Last of	Oct. — Last of	Sandy loam
214	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	Sandy loam
215	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	Sandy loam
216	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	Sandy loam
217	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	Sandy loam
218	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	Sandy loam
219	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	Sandy loam
220	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	April	Nov. 1	Sandy loam
221	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	April	Nov. 1	Sandy loam
222	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	April	Nov. 1	Sandy loam

TABLE NO. 5—*Continued*

Station No.	Amount of Cultivation.	Weight of Beet.		Per cent of Total, Solids.	Per cent of Sucrose.	Purity.
		Lbs.	Ozs.			
204	Irrigated once in 2 weeks, no cultivation	1	11	14.40	13.50	93.75
205	Irrigated once in 2 weeks, no cultivation	1		15.38	14.00	91.02
206	Irrigated once in 2 weeks, no cultivation		15	15.26	14.50	94.94
207	Irrigated once in 2 weeks, no cultivation		9	16.98	15.25	89.81
208	Irrigated once in 2 weeks, no cultivation		9	23.21	16.90	72.85
209	Cultivated once per week	2	5	12.60	10.75	85.33
210	Sown broadcast, not thinned or cultivated, irrigated twice per week		12	20.34	11.10	54.57
211	Sown broadcast, not cultivated or thinned, irrigated twice per week	1	8	11.41	8.20	71.87
212	Sown broadcast, not cultivated or thinned, irrigated twice per week		15	12.62	10.50	83.20
213	Hoed only once, irrigated only once	10	4	7.87	2.10	29.26
214	Hoed only once, irrigated only once	6	14	9.45	3.30	34.92
215	Hoed only once, irrigated only once	5	3	10.79	8.90	82.48
216	Hoed only once, irrigated only once	2	1	5.51	4.20	76.25
217	Hoed only once, irrigated only once	2	4	6.24	5.20	83.31
218	Hoed only once, irrigated only once	2	1	5.63	4.10	71.11
219	Hoed only once, irrigated only once		6	15.30	12.00	76.64
220	Plowed, irrigated once	2	7	13.60	10.30	75.73
221	Plowed, irrigated once	2	4	13.40	10.30	76.86
222		1	4	14.20	11.90	81.70

EXPLANATION OF TERMS USED IN TABLES.

By "total solids" is meant the entire amount of solid matter (sugar and other substances) in 100 parts of the juice (residue after evaporation of water from juice). By sucrose, is meant the amount of ordinary crystalizable sugar in 100 parts of the juice. By purity, is meant the amount of sucrose in the entire solid matter of the juice. To illustrate: Beet No. 208 analyzed total solids, 23.21; sucrose 16.90; purity, 72.85. This means that in every 100 pounds of the beet juice there are 16.90 pounds of sugar and 23.21 pounds solid matter. Also, that in every 100 pounds of this solid matter there are 72.85 pounds of sugar, or that the juice has a purity of 72.85 per cent.

In order to bring into prominence the "sugar content" of this season's beets, we have prepared table VI, showing all beets having a sucrose percentage below 12; table VII, showing all beets having a sucrose percentage between 12 and 18, and table VIII showing all beets having a sucrose percentage of 18 and over.

TABLE No. 6.

Showing Beets having Sucrose percentage below 12.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Sampling, Time of	Weight of Beet.		Total Solids	Sucrose in Juice	Purity
						Lbs.	Ozs.			
11	Orrin Ross	Reno, Washoe county	Dippe's Klein Wanzlebener	May 15	Sep. 10	2	12	11.99	7.00	62.00
15	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	June 3	Sep. 20	3	4	14.65	5.50	75.56
16	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	June 3	Sep. 20	1	9	13.42	11.50	85.70
17	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	June 3	Sep. 20		9	14.66	11.50	71.90
18	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20	4	3	13.66	6.00	43.92
20	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener		Sep. 20	1	15	10.67	9.00	84.35
25	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener		Sep. 20	1	3	14.12	11.20	81.17
40	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	2	6	13.20	11.20	84.09
41	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	2	6	12.73	8.80	69.12
43	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	4	10	11.64	8.00	68.71
44	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	1		14.31	10.20	71.27
52	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	4	14	15.09	8.20	54.34
53	A. G. Brown	Brown's Station, Washoe Co.	Betterave a Collet Rouge	May 24	Oct. 5	4	1	11.94	9.80	86.09
54	A. G. Brown	Brown's Station, Washoe Co.	Betterave a Collet Rouge	May 24	Oct. 5	3	6	12.06	8.90	73.79
55	A. G. Brown	Brown,s Station, Washoe Co.	Betterave a Collet Rouge	May 24	Oct. 5	1	9	13.05	10.00	76.62
56	E. E. Crane	Steamboat Springs, Washoe Co	Betterave a Collet Rouge	May 28	Sep. 25	1		14.11	11.60	82.21
57	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	May 28	Sep. 25	1	4	12.93	10.70	82.75
58	E. E. Crane	Steamboat Springs, Washoe Co	Betterave a Collet Rouge	May 28	Sep. 25		12	13.62	10.70	78.41
59	E. E. Crane	Steamboat Springs, Washoe Co	Betterave a Collet Rouge	May 28	Sep. 25	1	5	12.12	7.30	60.23
61	E. E. Crane	Steamboat Springs, Washoe Co	Betterave a Collet Rouge	May 28	Sep. 25	1	5	9.34	5.50	58.36
62	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 12	Oct. 3	1	7	13.78	10.00	72.55
63	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 12	Oct. 3	2	12	14.14	10.60	74.96
64	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 12	Oct. 3	2	1	13.71	11.50	83.87
65	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 5	Oct. 3	1	12	13.15	10.70	80.68
66	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 5	Oct. 3	1	2	12.43	8.60	69.18
67	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	May 5	Oct. 3	6	6	9.43	8.00	84.83
68	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			2	8	13.66	9.70	71.01
69	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			4	13	12.97	8.80	67.80
70	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			2	6	14.03	10.20	72.70
71	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			2	4	14.59	10.20	69.93

72	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			1	4	13.53	10.00	73.00
73	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			1	5	10.80	7.80	72.22
75	G. W. Crum	Battle Mountain, Lander Co.	Unknown			3	6	13.24	11.10	84.59
79	G. W. Crum	Battle Mountain, Lander Co.	Unknown			8	12	11.65	8.80	75.53
80	G. W. Crum	Battle Mountain, Lander Co.	Unknown			1	15	12.99	9.40	72.38
83	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			2	6	13.38	11.90	89.07
84	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			2	2	13.73	10.50	76.40
85	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			1	6	14.99	10.00	66.63
86	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			3	12	12.85	11.40	88.72
91	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener			6	7	12.77	7.90	61.86
92	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener			5	3	10.79	7.60	70.43
93	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener			6	13	12.50	9.00	72 00
94	Chas. Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener			7	8	18.64	6.30	33.97
102	Robt. Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	1	12	12.88	11.10	86.97
106	Louis Dutertre	Golconda, Humboldt connty	Unknown	March	Oct. 7	3	12	14.90	9.90	60.40
107	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	2	14	11.24	8.00	71.17
110	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	1	2	15.05	11.60	77.07
174	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	3	12	13.15	10.20	44.05
175	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	4	2	16.93	11.90	73.61
176	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	2	2	15.90	10.70	67.27
177	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	4	10	10.18	8.10	79.56
179	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20	Oct. 27	3	2	14.96	11.80	78.88
180	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20	Oct. 27	2	12	17.90	8.90	49.60
202	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sep. 10	2	7	19.30	9.00	46.63
209	Orrin Ross	Reno, Washoe county	Dippe's Klein Wanzlebener	May 16	Sep. 21	2	5	12.60	10.75	85.33
210	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	May 15	Nov. 5		12	20.34	11.10	54.57
211	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	May 15	Nov. 5	1	8	11.41	8.20	71.87
212	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	May 15	Nov. 5		15	12.62	10.50	83.20
213	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April —Last of—	Oct. —Last of—	10	4	7.87	2.10	29.26
214	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	6	14	9.45	3.30	34.92
215	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	5	3	10.79	8.90	82.48
216	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	2	1	5.51	4.20	76.25
217	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	2	4	6.24	5.20	83.31
218	O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	April	Oct.	2	1	5.63	4.10	71.11
220	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	April	Nov. 1	2	7	13.60	10.30	75.73
221	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	April	Nov. 1	2	4	13.46	10.30	76.86
222	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	April	Nov. 1	1	4	14.20	11.90	81.70

Table No. 7.

Showing Beets having Sucrose percentage between 12 and 18.

Station No.	Grower.	Postoffice Address.	Variety of Beets.	Planting, Time of	Sampling, Time of	Weight of Beet.		Total Solids	Sucrose in Juice	Purity
						Lbs.	Ozs.			
1	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Aug. 31	*	15	21.10	15.46	73.21
2	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Aug. 31	*	13	17.28	13.57	78.53
3	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 18	Aug. 31	*	11	18.40	16.00	86.09
4	Station Farm	Reno, Washoe county	French Desprez	May 18	Aug. 31	*	15	19.46	16.50	84.79
5	Station Farm	Reno, Washoe county	Desprez	May 19	Aug. 31	*	13	17.32	13.47	77.77
6	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Aug. 31	*	6	18.91	15.22	79.42
7	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Aug. 31	*	5	15.92	12.15	76 32
8	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Aug. 31	*	10	19.50	14.20	72.87
9	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 19	Aug. 31	*	10	21.58	17.50	81.09
10	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Aug. 31	*	9	14.91	12.00	80.49
13	Orrin Ross	Reno, Washoe county	Vilmorin's Improved	May 15	Sep. 10		9	14.80	12.00	81.00
14	Orrin Ross	Reno, Washoe county	Vilmorin's Improved	May 15	Sep. 10		14	14.25	12.00	84.00
19	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	June 3	Sep. 20		11	15.42	14.00	85.00
21	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20	3	2	21.82	13.25	60.72
22	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20		12	18.04	15.25	84.53
23	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20	1	1	14.99	12.10	80.73
24	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20	3	4	16.08	14.75	91.74
25	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20	2	13	13.25	12.30	92.84
26	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 11	Sep. 20		14	18.57	15.75	86.82
39	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Sep. 29	1	7	16.19	13.60	84.00
42	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	2	1	14.30	13.50	94.00
45	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 20	Oct. 1	1	13	15.85	12.50	72.55
60	E. E. Crane	Steamboat Springs, Washoe Co	Betterave a Collet Rouge	May 28	Sep. 25	1	3	17.73	14 16	84.05
74	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener			2	11	16.26	12.40	76.38
76	G. W. Crum	Battle Mountain, Lander Co	Unknown			2	3	15.28	12,10	79.18
77	G. W. Crum	Battle Mountain, Lander Co	Unknown			2	2	14.35	13.30	92.68
78	G. W. Crum	Battle Mountain, Lander Co	Unknown			1	13	15.32	13.40	87.46
81	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener				7	19.77	17.50	88.51
82	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			1		18.49	15.20	81.99
87	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			3	5	15.03	12.30	81,82

* Average of 6 beets.

88	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener				6	16.82	15.20	90.37
89	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener			1	8	16.26	14.10	88.74
90	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener			2	7	16.19	12.50	77.20
95	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener			8	12	15.43	13.60	88.13
96	Ross Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener	May	Oct. 11		14	22.84	17.50	76.66
97	Ross Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener	May	Oct. 11	1	6	17.29	14.70	85.01
98	Ross Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener	May	Oct. 11		12	17.58	15.40	87.09
99	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 9	2	6	19.71	17.00	86.26
103	Robert Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	1	12	14.35	12.30	85.71
104	Robert Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	1	15	16.99	13.90	81.81
105	Robert Eason	Reno, Washoe county	Betterave a Collet Rouge	June 8	Oct. 9	1	7	17.58	14.20	80.77
108	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	2	0	14.00	13.00	84.57
109	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	1	12	14.53	12.50	83.27
111	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	1	5	15.58	13.20	84.85
112	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	1	5	17.52	15.00	83.35
114	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	2	1	16.42	15.10	96.38
115	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	1	4	19.39	17.40	89.76
118	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19		9	19.88	17.40	87.53
120	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	1	4	19.59	17.20	87.59
122	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19		14	19.02	17.30	93.08
126	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20		12	17.21	16.40	97.56
127	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20		11	17.91	14.20	79.31
128	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20		9	14.64	12.80	87.67
129	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20		15	15.76	13.90	88.02
130	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20		10	17.20	14.90	86.62
131	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 20		8	17.54	16.30	92.93
147	F. Dangberg	Genoa, Douglas county				3	1	15.80	13.20	83.53
148	F. Dangberg	Genoa, Douglas county				2	3	14.11	13.70	97.08
149	F. Dangberg	Genoa, Douglas county				1	14	12.83	12.60	95.83
150	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23		15	16.78	16.30	97.10
151	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23		14	15.92	14.90	93.59
152	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23		8	18.70	16.60	88.85
153	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	May 27	Oct. 23		9	19.52	17.90	91.49
155	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23	1	1	18.44	16.40	88.94
158	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Oct. 23		8	16.94	15.90	98.34
159	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener		Oct. 23		6	13.89	12.70	91.53
160	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Oct. 23		5	17.35	15.60	71.41
161	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	July 1	Oct. 23		6	19.24	16.10	81.77
162	D. H. Dillard	St. Clair, Churchill county	Desprez				12	17.64	16.30	92.41
163	D. H. Dillard	St. Clair, Churchill county	Desprez				7	21.88	17.80	81.25
164	D. H. Dillard	St. Clair, Churchill county	Desprez				9	19.74	14.90	75.47
165	D. H. Dillard	St. Clair, Churchill county	Desprez				10	17.15	15.40	71.16
166	D. H. Dillard	St. Clair, Churchill county	Desprez				10	20.60	16.10	78.13
167	D. H. Dillard	St. Clair, Churchill county	Desprez				12	20.05	17.10	85.24
168	D. H. Dillard	St. Clair, Churchill county	Desprez				14	19.29	17.10	91.17

TABLE No. 7—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Sampling, Time of	Weight of Beet.		Total Solids	Sucrose in Juice	Purity
						Lbs.	Ozs.			
169	D. H. Dillard	St. Clair, Churchill county	Desprez				9	19.55	17.20	87.97
170	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	1	12	14.25	13.10	92.11
171	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24		13	17.17	15.80	91.99
172	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	1	1	16.05	15.70	97.82
173	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	May 17	Oct. 24	1	7	16.86	15.50	91.95
178	F. Dangberg	Genoa, Douglas county				1	2	14.66	12.10	82.55
184	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	1	8	20.09	17.90	89.09
185	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	1	2	21.19	15.90	75.03
186	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24		13	19.97	16.70	83.62
187	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24		8	21.76	17.10	78.58
191	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20	Oct. 26	1	7	18.35	16.90	92.09
192	S. J. Bryant	Reno, Washoe county	Betterave a Collet Rouge	May 20	Oct. 26		13	22.72	17.60	77.46
194	John Harrison	Lovelocks, Humboldt county	Unknown seed from Spreckles	May 1	Oct. 15	1	7	18.19	15.90	87.37
197	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 24	2	12	19.80	17.20	86.88
198	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 24	2	14	20.02	17.60	87.91
203	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sept.	1	12	14.91	13 00	87.19
204	A. Litch	Reno, Washse county	Verbesseter Klein Wanzlebener	May	Sept.	1	11	14.40	13.50	93.75
205	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sept.	1		15.38	14.00	91.02
206	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sept.		15	15.26	14.50	94.94
207	A. Litch	Reno, Washoe covnty	Verbesseter Klein Wanzlebener	May	Sept.		9	16.98	15.25	89 81
208	A. Litch	Reno, Washoe county	Verbesseter Klein Wanzlebener	May	Sept.		9	23.21	16.90	72.85
219	O. J. Douglas	Reno, Washoe county					6	15.30	12.00	76.64

TABLE NO. 8.

Showing Beets having Sucrose percentage of 18 and over.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Planting, Time of	Sampling, Time of	Weight of Beet.		Total Solids	Sucrose in Juice	Purity
						Lbs.	Ozs.			
46	E. T. George	Lewis, Lander county	Verbesseter Klien Wanzlebener	May 12	Oct. 1	1	2	24.72	20.90	82.91
47	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 12	Oct. 1	1	10	22.05	19.60	88.88
48	E. T. George	Lewis, Lander county	Vilmorin's Improved	May 12	Oct. 1	1	2	23.04	20.20	87.63
49	E. T. George	Lewis, Lander county	Betterave a Collet Rouge	May 12	Oct. 1		4	23.56	19.00	80.64
50	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	May 12	Oct. 1		12	24.91	21.80	87.09
51	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	May 12	Oct. 1		9	33.80	26.20	77.51
100	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 9		8	26.47	22.50	85.31
101	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 9		8	27.40	23.80	86.86
113	Louis Dutertre	Golconda, Humboldt county	Unknown	March	Oct. 7	1	2	20.44	18.60	90.95
116	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19	1	3	20.08	18.50	92.22
117	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19		13	19.77	18.90	93.42
119	Station Farm	Reno, Washoe county	Vilmorin's Improved	May 4	Oct. 19		8	21.89	20.10	91.83
121	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19	1	4	19.63	18.20	92.73
123	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19		12	21.26	20.20	94.13
124	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19		9	21.17	20.50	96.82
125	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 19		6	21.14	19.50	92.56
132	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20		9	20.98	18.50	88.19
133	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20		14	22.48	21.60	96.12
134	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20		14	22.68	21.90	94.36
135	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20		9	22.51	20.80	95.55
136	Station Farm	Reno, Washoe county	Desprez	May 10	Oct. 20		8	22.68	21.20	93.47
137	Station Farm	Reno, Washoe county	Desprez	May 19	Oct. 20		9	22.12	21.20	95.87
138	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20		10	23.60	22.00	94.07
139	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20		12	22.37	18.60	85.07
140	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20		14	22.16	21.10	95.26
141	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20		10	23.65	18.20	76.97
142	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20		8	22.87	21.90	91.72
143	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 20		5	22.30	21.40	98.19
144	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener			1	9	23.51	17.30	74.00

Table No. 8—*Continued.*

Station No.	Grower.	Postoffice Address.	Variety of Beets.	Planting, Time of	Sampling, Time of	Weight of Beet.		Total Solids	Sucrose in Juice	Purity
						Lbs.	Ozs.			
145	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener				14	26.80	21.10	79.04
146	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener				3	24.22	22.00	92.96
154	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23	1	2	20.78	19.90	95.75
156	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23		13	22.10	19.10	86.41
157	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 23		11	23.20	20.80	87.61
181	J. W. Haines	Genoa, Douglas connty			Oct. 17		5	25.45	21.80	85.64
182	J. W. Haines	Genoa, Douglas county			Oct. 17		3	24.02	21.00	87.43
183	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24	1		19.26	18.00	93.40
188	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	May 27	Oct. 24		8	23.22	21.70	93.43
189	Station Farm	Reno, Washoe county	Stray beet	May 4	Oct. 28		6	23.86	22.00	92.23
190	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 4	Oct. 28		15	23.29	21.00	88.13
193	John Harrison	Lovelocks, Humboldt county	Unknown seed from Spreckles	May 1	Oct. 15	1	2	22.24	18.90	81.37
195	John Harrison	Lovelocks, Humboldt county	Unknown seed from Spreckles	May 1	Oct. 15		8	22.59	21.10	94.26
196	John Harrison	Lovelocks, Humboldt county	Unknown seed from Spreckles	May 1	Oct. 15		11	21.66	19.90	91.45
199	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 19	Oct. 24	1	8	21.95	20.10	91.56
200	Station Farm	Reno, Washoe county	Desprez	May 18	Oct. 24	1	11	24.25	21.10	87.03
201	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	May 19	Oct. 24	1	3	22.15	20.10	90.75

It will be seen from an examination of the above tables that of the 210 samples analyzed 67 had a sucrose percentage under 12; 97 a sucrose percentage between 12 and 18, and 42 attained a percentage of 18 and over. This certainly goes far toward showing the possibilities of Nevada as a sugar beet producing State.

GENERAL AVERAGES.

The following table (No. IX) shows what the several varieties have done this year, under all the various conditions to which they have been subjected. In juxtaposition with this table is placed table No. III, giving only averages of varieties as grown on Station Farm. This shows what the varieties can be made to do under careful cultivation and close attention. There were several samples sent in, the seed of which was obtained from seed stores and other parties, and the varieties were unknown, so could not figure in this table.

TABLE No. 9.

Showing average analyses of the several varieties, State at large.

VARIETY OF BEETS.	Total Solids.	Sucrose in Juice.	Purity.
Dippe's Klein Wanzlebener	19.39	15.32	78.95
Vilmorin's Improved	18.71	17.06	91.18
Desprez	20.62	19 32	95.55
Betterave a Collet Rouge	15.72	12.57	80.09
Improved Klein Wanzlebener	16.60	10.82	65.06
Verbesseter Klein Wanzlebener	12.60	11.46	90.97

TABLE No. 3.

Showing average analyses of different varieties grown on Station Farm.

VARIETY.	Solids.	Sucrose.	Purity,
Dippe's Klein Wanzlebener	21.79	19.41	89.07
Vilmorin's Improved	19.57	17.90	91.46
Desprez, May 18	22.39	20.05	89.54
Desprez, May 19	21.66	20.00	92.38
Improved Klein Wanzlebener	20.93	17.88	85.42
Betterave a Collet rouge	17.12	15.42	90.07
Improved Klein Wanzlebener, July 1	16.18	15.07	93.13

As far as is indicated by sugar content alone, those varieties which have done the best over the State at large are Desprez, Vilmorin's Improved and Dippe's Klein Wanzlebener.

* The general average of all samples received is: Total solids, 17.17 per cent.; sucrose, 13.20 per cent.; purity, 76.87 per cent.

This average, while not as high as we could desire, is very fair and exceeds that of Germany last season, which was estimated at 12.55 per cent. Two of the factors quite prominent in lowering this average of sucrose percentage, are lack of proper cultivation, permitting the beets to grow too large, and the raising of beets on strong alkali soils. The sugar beet is a "thoroughbred, and must be treated as such." All points of cultivation must be followed carefully. One of the most important things to be guarded against is allowing the beet to attain an enormous size.

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* In making up this average sample No. 51, analyzing 26 per cent. was thrown out.

Many of the samples sent in were very large and poor in sugar. They were evidently sent with the mistaken idea that large, overgrown beets are good sugar producers. Some samples weighed from 7 to 10 pounds and analyzed from 5 to 2 per cent. sucrose.

Table X shows that in general sugar content is in inverse ratio to the size of the beet. There are of course exceptions to this rule, but the results of this and other stations prove it to be the general law at the present time. The beet best adapted alike to the interests of farmer and manufacturer, is the one weighing from a pound to a pound and a quarter and containing on an average 14 per cent. sucrose and having a purity of at least 80.

As beets increase in size and weight above a certain limit, say 2½ to 3 pounds, the percentage of water increases and the sucrose decreases, thus giving the manufacturer a much larger amount of tankage (juice) to evaporate and the farmer—if he be paid per unit of sugar in beets—a much smaller profit for his product. Prof. C. L. Ingersol of Nebraska estimates that a beet weighing 8 pounds and containing 8 per cent. of sucrose, compared with a beet weighing 3 pounds and containing 14 per cent. sucrose will reduce the working capacity of a factory by one-half.

Beets have, to a great extent, the power of absorbing mineral salts from the soil, and when grown upon alkali land, such as is found in portions of this State, must take up large quantities of these salts, which form part of the total solids, thus reducing the per cent. of purity. It would also seem that these mineral salts hinder the formation of saccharine matter and renders that which does form, very hard to extract, as they prevent crystalization. Such beets, therefore, would seem to be of commercial use only for distilling. If beets are allowed to grow partially above ground, just so much is wasted for sugar manufacture, as it contains such a large proportion of mineral salts. In general, the sucrose increases from the top to the bottom of the beet. This fact is clearly shown in Table XI, which gives analyses of the upper and lower halves of 5 samples.

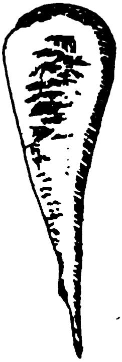
Table No. 10.

Showing relation of size of beet to sugar content.

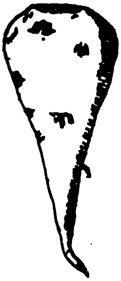
Grower.	Postoffice Address.	Variety of Beets.	Measurements.			Weight of Beet.		Solids	Sucrose	Purity
			Length, inches.	Crown, inches.	Middle, inches.	Lbs.	Ozs.			
E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	12	15	9½	4	10	11.64	8.00	68.71
E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	10	12	8	2	6	13.20	11.20	84.09
E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	11	11½	8½	2	1	14.30	13.50	94.00
D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	12½	14½	12¾	3	12	12.85	11.40	88.72
D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	11	16	14	3	5	15.03	12.30	81.82
D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	8	15½	9	1	0	18.49	15.20	81.99
D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	10	7¾	5	------	7	19.77	17.50	88.51
Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	13	20	18	7	8	18.64	6.30	33.97
Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	11½	18	14	5	3	10.79	7.60	70.43
Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	7½	14¼	12	2	7	16.19	12.50	77.20
Station Farm	Reno, Washoe county	Vilmorin's Improved	9	13	10½	2	1	16.42	15.10	96.38
Station Farm	Reno, Washoe county	Vilmorin's Improved	10½	10	7½	1	4	19.39	17.40	89.76
Station Farm	Reno, Washoe county	Vilmorin's Improved	8½	9½	6¼	------	13	19.77	18.90	93.42
Station Farm	Reno, Washoe county	Vilmorin's Improved	6¼	8	5	------	8	21.89	20.10	91.83
Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	9½	12	8½	1	4	19.59	17.20	87.59
Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	9½	10½	7	------	14	19.02	17.30	93.08
Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	6½	9½	6¾	------	12	21.46	22.20	94.13
Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	7	9	5½	------	9	21.17	20.50	96.82
H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener	10½	11	8	1	9	23.51	17.30	74.00
H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener	9	10½	5½	------	14	26.80	21.10	79.04
H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener	6	4¾	3¾	------	3	24.22	22.00	92.96
H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	14	12½	13	3	12	23.15	10.20	44.05
H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	15	13	13¼	2	2	15.90	10.70	67.27
H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	13	10¼	8	1	7	16.86	15.50	91.95
H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	11	10	7¾	1	1	16.05	15.70	97.82
H. H. Springmeyer	Gardnerville, Douglas Co.	Improved Klein Wanzlebener	13½	12½	6½	------	13	17.17	15.80	91.99
O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	16	22	18	10	4	7.87	2.10	29.26
O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	15½	19	16	6	14	9.45	3.30	34.92
O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	11½	12½	11¼	2	4	6.24	5.20	83.31
O. J. Douglas	Reno, Washoe county	Verbesseter Klein Wanzlebener	8¾	7	3½	------	6	15.30	12.00	17.64

The cuts here presented are made directly from photographs of samples sent in for analyses and are forcible arguments in support of the general law that per cent. of sucrose is in inverse ratio to the size of the beet. The numbers refer to station numbers as found in Table V.

Types of Beets grown on Station Farm.



199



200

201

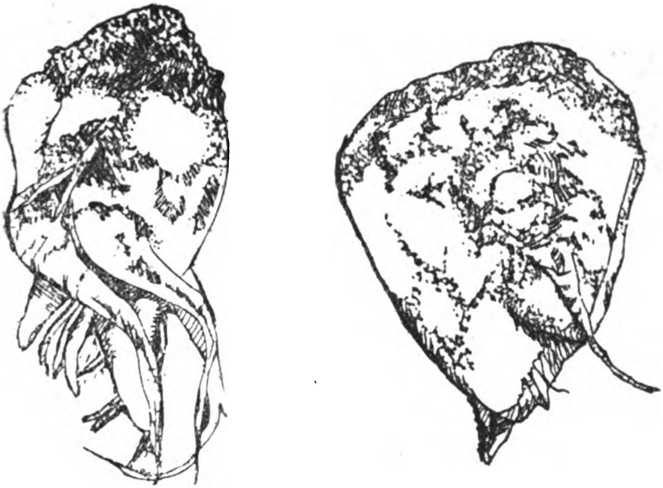
No. 199—Weight, 1 pound 8 ounces; sucrose, 20.10 per cent.
No. 200—Weight, 1 pound 11 ounces; sucrose, 21.00 per cent.
No. 201—Weight, 1 pound 3 ounces; sucrose, 20.10 per cent.

117

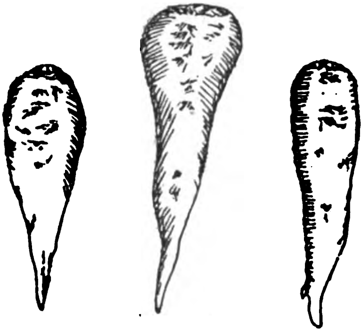
123

No. 117—Weight, 13 ounces; sucrose, 18.90 per cent.
No. 123—Weight, 12 ounces; sucrose, 20.20 per cent.

Types sent in by Farmers.



A—Weight, 7 pounds 8 ounces; sucrose, 6.30 per cent.
B—Weight, 6 pounds 7 ounces; sucrose, 7.90 per cent.



C—Weight, 14½ ounces ; sucrose, 15.30 per cent.
D—Weight, 1 pound 4 ounces ; sucrose, 14.90 per cent.
E—Weight, 14½ ounces ; sucroce, 15.60 per cent.

TABLE No. 11.

Showing variations of sucrose in upper and lower halves of beets.

Number.	Total Solids.		Sucrose.		Purity.	
	Upper Half.	Lower Half.	Upper Half.	Lower Half.	Upper Half.	Lower Half.
1	10.51	11.51	7.00	8.70	66.60	75.58
2	12.98	12.89	9.50	10.40	73 11	80.68
3	23.01	11.64	4.40	7.50	19.12	64.43
4	14.37	17.14	10.00	14.60	69.58	85.18
5	20.40	19.23	14.90	18.00	73.03	93.60

When beet seed was sent out to farmers in the Spring each one was asked to report method of treatment for the season. After work had commenced on this bulletin it was thought best to send a list of questions that should cover the principal points of the season's operations, but the time being short, the full list was sent to only two farmers. We desire to hear from all who have raised beets the past season, as the work of practical farmers—those who will raise beets in quantity, should a factory be gained for Nevada—will be a valuable contribution to the experiment.

1. Date of seeding.
2. Amount of seed used per acre.
3. Do you use a garden drill.
4. Amount of ground seeded.
5. Distance of rows apart.
6. Depth of seeding.
7. Number of cultivations with a horse.
8. Number of times hoed.
9. Number of times irrigated.
10. Kind of soil.
11. Date of harvest.
12. What use will you make of the beets.
13. How many acres of beets can farmers raise to advantage in your vicinity.
14. What does it cost you to raise an acre of beet.
15. Have you previously raised sugar beets ; if so to what extent.
16. How many tons did you raise to the acre, weight, measure or estimate.

Mr. H. H. Springmeyer, of Genoa, replied as follows :

1. May 17, 1891, on sagebrush land, seed planted.
1. June 3, 1891, on river bottom land, seed planted.
2. Planted 8 pounds seed on sagebrush land.
2. Planted 6 pounds seed on river bottom land.
3. No drill used.
4. One-half acre bottom land, 60 rods sagebrush, 20 rods clay land.
5. Distance of rows apart, about 30 inches.
6. Depth of seeding, one inch.

7. Once cultivated with horse on sagebrush land and twice on bottom land.
8. Number of times hoed, once.
9. Number of times irrigated, three.
10. Sagebrush land, sandy loam, 20 rods on heavy clay and one-half acre river bottom.
11. Date of harvesting river bottom land, October 24; sagebrush land, October 27.
12. Feeding to hogs and milch cows.
13. About 10,000 acres if there is a factory.
14. Cost of raising one acre, without paying rent, $35.
15. I have never raised beets in the United States before.
16. On one-half acre bottom land, 26,420 pounds; on 60 rods sagebrush land, 17,205 pounds; on twenty rods clay land, 3,950 pounds.

Mr. John Harrison, of Lovelocks, estimates that 10,000 acres of beets could be raised in his vicinity.

FACTORIES.

We hear the statement occasionally made that the factory price for beets, of four or five dollars per ton, will not pay for raising. Whether it will pay or not, is difficult to tell to a certainty, until beets have been raised in quantity. Those who have raised half an acre or more of sugar beets will be able to judge, to quite an extent, of the cost, desirability of raising beets for sale, and at what prices they can afford to sell. Nevada farmers will readily understand, that with the most approved machinery for sugar beet cultivation and from ten to five hundred acres sown, the cost per acre will be much less than with a single acre. Like any new enterprise that the farmers propose embarking in, it will pay well to look the ground over thoroughly before starting, so that the large majority, at least, will not regret the venture. During the past season Mr. Spreckles was written, and asked if the statement made in a Denver paper was correct—that he would put up a factory where an agreement was made that two thousand acres would be cultivated in sugar beets. His deputy replied, saying that Mr. Spreckles was in Europe for a year and that nothing could be done in his absence.

Mr. Henry T. Oxnard, of Grand Island, Nebraska, who was asked: "On what basis will you erect a sugar factory in Nevada?" replied:

"We propose receiving bids from every point in the United States that wants a beet sugar factory, and will locate it where we receive the largest bonus, provided the soil is such as would warrant us in establishing a plant there which would work about thirty thousand tons of beets per year.

"Here, at Norfolk, we received a bonus of $100,000 cash and $50,000 in bonds. This will give you an idea of what might be expected."

Mr. A. G. Duysters, of New York, states in a letter that he has "lately returned from Germany and the continent generally, having had as my object to thoroughly acquaint myself with beet sugar manufacture and the raising of beets. Arrangements have been made in the interest of a projected company to foster the development of the beet sugar industry. This it will do by acting as agent for the local companies, purchasing the machinery and obtaining the skilled labor and necessary seed, taking a small percentage of the stock for the expense, which will include the inspection of all machinery and other supervision necessary. Or the parent company will furnish everything necessary at its own cost and take a controlling interest in the local companies if the latter arrangement is preferred."

The Sugar Beet for November says that at Albuquerque, N. M., "a company has just been organized here, and the stock is now nearly all taken for the building of a factory for the manufacture of sugar from beets. The intention is to start with a plant that can be put in for about $150,000, and enlarge the capacity as the production of beets increases."

Marshalltown, Iowa, is to have a factory with a paid up capital of $550,000. The citizens subscribe for $50,000 worth of stock and donate forty acres of land.

" At Chino, California. the amount of capital already put in the sugar factory foots up $926,000. It will require fully $1,100,000 to get the institution in full running order. The immense machinery in the buildings was made in Stuttgart and Hamburg, Germany, at a cost of $330,000 and the freight, setting up and putting in shape cost $14,000 more. The labor bill at Chino, since last November, has been $78,000. The brick for the building has been made on the ground and 20 men have been employed on that alone. Thus far 4,300,000 brick and 600 barrels of cement have been used. The machinery came to New Orleans by ship and from that city to Chino by railroad. When the factory is in running order it will be able to turn out 860 barrels of sugar every 24 hours, but that capacity will not be reached for several years, on account of the lack of beets for use. The time consumed in converting the beet, as it comes from the soil, into pure, granulated sugar, will be 16 hours, and there is only one factory in Germany that can make pure sugar from the raw product in less than 19 hours.

Speaking of the beet sugar industry, the San Francisco *Chronicle* gives the following figures:

In order to supply the home demand for sugar, in our own country, it would require 700 establishments similar to those now in operation at Grand Island, Nebraska, and at Alvarado and Watsonville in this State. The average capital invested in a factory capable of handling 300 tons of beets daily, is $500,000. For a hundred days' campaign 30,000 tons of beets would be needed at a cost of about $150,000. For fuel, 5,000 tons of coal would cost at least $25,000. For establishment, at least 3,000 acres of ground and 200 men would be needed. For the 700 factories needed to supply the demand in the United States, it would take 2,100,000 acres of beets, and at least 2,000,000 men would be needed to cultivate and harvest the crop, the work lasting about 6 months each year. Each season some $105,000,000 would be paid out for beets and $91,000,000 for fuel and working expenses, while $350,000,000 capital would be needed for the plants of the sugar factories.

Farmers will readily understand that one year's experiment with beets or any crop is not final, although the results with sugar beets at the Station, and as far as reported by farmers are encouraging. The Station beets and those from widely separated sections of the State have analyzed from 2 to 22 per cent. sugar. The factory at Grand Island, Nebraska, at last accounts, would purchase beets yielding 12 per cent. sugar. A newspaper item credits Mr. Spreckles with the statement that beets should analyze 14 per cent. for manufacturing purposes.

Dr. Wiley, of Washington, says in Bulletin 30, U. S. Department of Agriculture, that beets containing 15 to 18 per cent. of sugar may be regarded as strictly normal in constitution but possessing a particularly high content of sugar. When, however, the content of sugar in the beet exceeds 18 per cent. it must be regarded at the present as something abnormal."

Perhaps we cannot raise beets every year that will analyze 22 per cent. sugar. We should expect, for the present, at least, that the majority would fall below this, and yet it is worth thinking of, worth investigation to learn if beets analyzing 22 per cent. can be raised in quantities, and if not, why not.

From a late Nebraska paper the following, on sugar beets, is taken:

The opening of the beet sugar mills at Grand Island and Norfolk this Fall, shows that while the beet crop this year is a great deal larger than last, the amount of sugar to the pound is somewhat less.

It is somewhat a work of time to impress the beet farmer that big, ten-pound roots are not wanted. They are not good for making sugar.

Prof. Nicholson, the authority on sugar beets in the West, has been studying the size for Nebraska, and has about come to the conclusion that with proper selection and crossing a much larger sugar producing beet can be grown here than in Europe, and that even now our three-pound beets are as rich in sugar as the pound and a half roots of Germany and France. This is encouraging, as it shows the better adaptability of our soil and climate to sugar culture than those of the beet-producing sections of Europe.

If the three pound beet proves to be the beet for Nebraska, is it to a certainty the one for Nevada? To handle it would be an advantage, as the three pound root could be thrown into a wagon or slicer as fast as one weighing one or two pounds. Two beets (No. 197, 198) from Station's grounds, weighing 2 pounds 12 ounces, and 2 pounds 14 ounces, analyzed 17.2 and 17.6 per cent. sugar.

MANUFACTURE OF SUGAR.

From the Reno *Gazette* of April 24 we take the following:

The report of the Society of Agriculture contains the following on beet sugar, and the cost of manufacturing the same, which may prove interesting reading:

The question is often asked if beet sugar cannot be made in a small way so that six or seven farmers could club together, put up a cheap apparatus and produce their own sugar. On account of the elaborateness of the process and costly nature of the machinery which is necessary to produce beet sugar even in a small way, it is not believed that it could be profitably made in the way indicated.

The cost of manufacture depends on as many factors as that of beet growing. Chief among these are transportation, fuel, weather and labor. Perhaps the most important of these factors is the price of fuel. In some localities coal can be had for $1 25 per ton; in others it may reach as high as $10 per ton.

The manufacture of beet sugar is still so much of an experiment in this country as to render any exact amount of its cost impossible. To show what it may be with large experience and the highest skill and management, I give the mean cost of manufacture in 113 German factories from data of the campaign of 1889–90.

Mean capital infested in each factory		$193,400
Total receipts for sugar, molasses and pulps per ton of beets		$11 10
Mean cost of beets per ton of 2,220 pounds	$4 90	
Salaries per ton of beets	26	
Labor per ton of beets	73	
Interest on investment per ton	36	
Coal per ton of beets	63	
Miscellaneous expenses per ton	96	
Total expense of manufacturing per ton		7 84
Profit per ton of beets		$3 26

The mean net profit for each factory was $34,240. The price paid for beets, however, is in most cases fictitious, the beet growers owning the factory and preferring to share in the general profits rather than charge a high price for the beets. First-class beets rarely sell for less than $5.25 per ton.

SUMMARY.

1. The strong probability is that early sowing—just as early as ground can be worked, and plants will not be injured by frost—will, so far as sowing effects results, give best returns.

2. Thin to one beet in a place. Each season's experience will give the farmer suggestions on culture that will reduce the cost.

3. The weight of evidence goes to show that the per cent. of sucrose is in inverse ratio to size of the beet. Therefore, for the present it is probably safer to stick to the medium size beet of from one to two pounds weight.

4. Do not let half of the beet grow above ground, as that means less sugar, which means less dollars and cents.

5. In raising beets for sugar, avoid alkali land, as the seeming tendency is to hinder sugar formation. It may be well, however, to experiment some with alkali soil, for there is a probability that successive crops will aid in removing the alkali, thus producing better beets each year.

6. Beets analyzed at this Station varied in sucrose percentage from 2.10 to something over 23.00 (one perfectly fresh sample analyzing 23.80). Forty-six per cent. of all samples analyzed contained between 12 and 18 per cent. sucrose, and 20 per cent. contained over 18 per cent. sucrose.

7. The results of the season's experiments demonstrate—as far as one season's work can—that Nevada can raise sugar beets of a quality profitable for manufacture.

8. The Station would like the co-operation of all farmers interested in beet culture, in the sugar beet experiments for 1892, and will furnish a limited amount of seed.

Please acknowledge receipt of this Bulletin.

POTATO EXPERIMENTS.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 14.

RENO, NEVADA, DECEMBER, 1891.

Agricultural Experiment Station.

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This Station is prepared to analyze and test fertilizer's soils, muck, which may be of agricultural value, gypsum, which may be useful for reclaiming alkali lands, cattle foods, water, milk and dairy products, seeds, with reference to their germinating power and purity; to identify grasses and weeds and study forage plants ; to investigate the diseases of fruit and fruit trees, grains and other useful plants ; to make reports on injurious insects and the most practical means of combatting them.

THIS WORK IS DONE GRATIS FOR RESIDENTS OF THE STATE.

The Bulletins and Reports will be sent free to any farmer or other person interested in agriculture within the State.

Address all communications to

Agricultural Experiment Station,
Reno, Washoe County, Nevada.

Please acknowledge receipt of this Bulletin.

POTATO EXPERIMENTS.

R. H. McDowell. N. E. Wilson.

One of the farm products which Nevada raises in large quantities and of excellent quality is the potato. At the Station grounds, for the season of 1891, 52 selections were made from 90 varieties. the object in selecting being to reduce the number under cultivation, choosing only those that had given the best returns.

These were planted near the central portion of the grounds, the soil being practically the same as described in Bulletin No. 13, sandy, gravely, with a small portion of clay.

The land selected for the experiment with the 52 varieties was a quarter-acre plat which had been manured at the rate of 35 two-horse loads per acre, and was plowed in February, 1891.

For the varieties planted in larger area, half-acre plats were used, occupying land seeded to alfalfa.

These were plowed in March, '91, using from four to six horses. Dynamite was used in blasting rock, of which many tons were removed, together with a large quantity of alfalfa roots.

The ground was well harrowed and crossplowed. After the second plowing more rock and alfalfa roots were removed. The harrow was used again, followed by a "smoother."

PLANTING.

The rows were laid off three feet apart, running a light furrow for the seed, which was cut to two eyes.

In planting, one piece of seed was used to each hill; the hills were placed exactly two feet apart.

Fifty-four hills of each variety were planted. The covering was done with a single shovel plow to a depth of about four inches.

The date of planting, for one to thirty-two, was April 30th; for thirty-three to fifty-two, May 6th.

With more than a usual amount of rain and an excess of cool weather, the coming up was not rapid, the majority showing from May 23 to 28.

The cultivation, largely done with a single shovel plow, was sufficient to keep the ground in good condition and clear of weeds.

IRRIGATION.

Furrows, fairly deep, were made between the rows to carry the water and also keep it below the potatoes, instead of allowing it to come up onto the hills.

The plat occupied by the 52 varieties was irrigated June 5, 18, 27; July 5, 11, 18, 29; August 4, 13 and 25.

The half-acre plats, on which grew the Morning Star, Fearnaught, White Star, Early Rose, White Flower, St. Patrick, Rough Diamond, Early Sunrise, Stray Beauty and Summit were irrigated on June 3, 17, 26; July 5, 11, 20, 28; August 4, 12 and 25.

The following table gives a portion of the field notes on growth and general appearance of the different varieties on August 20th. The width and height of tops is given in inches:

Date.	Name	Hight of tops —inches	Width of tops —inches	General Appearance.
August 20	Stray Beauty	8	15	Below average
August 20	Dictator	12	16	Medium
August 20	Summit	12	17	Average food
August 20	White Star	15	20	Above average
August 20	Queen of the Valley	11	16	Below average
August 20	Mullally	11	17	Medium
August 20	Green Mountain	14	20	Above average
August 20	Early May Flower	12	18	Medium
August 20	Crane's Extra Keeper	13	17	Medium
August 20	Northern Spy	12	18	Medium
August 20	Early Market	7	12	Poor
August 20	Early Rose	12	20	Good
August 20	Rough Diamond	13	28	Good
August 20	Ross	14	24	Good
August 20	Early Sunrise	14	24	Good
August 20	Morning Star	20	29	Extra good
August 20	Fearnaught	17	27	Extra good
August 20	Vanguard	14	23	Extra good
August 20	Triumph	6	12	Very poor
August 20	Early Ohio	14	23	Good

Date.	Name.	Height of tops—inches	Width of tops—inches	General Appearance.
August 20	St. Patrick	15	30	Extra good
August 20	Beauty of Hebron	10	20	Medium
August 20	Pearl of Savoy	13	25	Good.
August 20	Governor Foraker	11	17	Medium
August 20	Princess	7	16	Below average
August 20	Monroe Co. Prize	10	18	Good
August 20	Howe's Premium	6	12	Poor
August 20	Minister	7	13	Poor
August 20	Bill Nye	13	20	Good.
August 20	Polaris.	7	14	Poor
August 20	Vick's Perfection.,	8	18	Poor
August 20	Roanoke	7	14	Poor
August 20	Nott's Victor	8	17	Below average
August 20	White Flower	13	22	Extra good.
August 20	Six Weeks	7	15	Poor
August 20	New Champion	8	18	Medium
August 20	Thorburn	8	17	Medium
August 20	Winner.	15	23	Extra good
August 20	Charles Downing	9	18	Medium
August 20	Jumbo	11	23	Good
August 20	White Elephant	15	22	Extra good
August 20	Snow Flake	13	23	Extra good
August 20	Empire State	15	23	Extra good
August 20	Pride of the West	13	18	Good
August 20	Delaware.	12	20	Good.
August 20	Clark's No 1	7	13	Below average
August 20	Early Marine	11	19	Medium
August 20	Brownell's Best	8	17	Medium
August 20	Early Durham	8	16	Medium
August 20	Finch's Perfection.	7	12	Poor
August 20	Potentate	10	16	Good
August 20	Centennial	10	16	Good

DIFFERENT AMOUNTS FOR SEED

Four rows, each 132 feet long, of the White Flower were planted May 9th, using seed cut to one and two eyes, also half and whole potatoes.

AMOUNT OF SEED.	Hills germinated	Date of harvest.	Large—lbs	Small—lbs.	Total—lbs.	Calculated to 83 hills—lbs
One eye	70	October 20.	69½	15	84½	100¼
Two eyes.	81	October 20.	87	23¼	110¼	112 15-16
Half potato.	83	October 20.	61¾	37½	99¼	99¼
Whole potato	83	October 20.	51¼	79¾	131	131

It will be noticed that the amount of small potatoes becomes greater as the seed is increased from one eye.

The per cent. of small potatoes is least with one eye and greatest where whole potatoes were used, although the latter gives best results for total weight.

HALF-ACRE PLATS.

In the table below are given notes on varieties grown on the half-acre plats, area given to each, yield in pounds, and calculated yield in bushels per acre.

One of the varieties, the Rough Diamond, varies in appearance from the usual more than any potato we have. It has a rough, brown skin, and nearly round in shape.

Some who have tried it pronounce it a fair cooking potato, while others say it has nothing of value except its blight resisting qualities.

The plantings of June 1st, June 15th, and July 1st, were for a limited test of late planting.

The Early Sunrise of July 1st, ripened and produced good sized potatoes.

From 58 hills we harvested of large potatoes 24¼ pounds, of small potatoes 8¾ pounds. Three hundred and nine hills of the Early Sunrise, planted May 11th, using the seed end, yielded of large potatoes 94¼ pounds, of small potatoes 22 pounds.

NAME.	Date planted.	Date harvested.	Area in feet.	Yield—lbs.	Yield per acre in bushels..
Morning Star	May 9	October 20	36x132	1,485¼	226
Fearnaught	May 11	October 16	48x132	1,649	188
White Star	May 9	October 19	45x132	2,215	270
Early Rose	May 9	October 17	42x132	1,401¾	183
White Flower	May 9	October 20	9x132	425	259
St. Patrick.	May 9	October 20	18x132	828	253
Rough Diamond	May 19	October 17	30x132	608	111
Early Sunrise	June 15	October 17	12x132	430½	197
Stray Beauty	June 1	October 17	18x132	518¾	158
Summit	May 11	October 16	12x132	601¼	275

The number of rows planted of the above varieties was varied to suit the amount of seed on hand.

Sixty pounds per bushel were used in estimating acre yields. In the final result any number of pounds less than sixty were not counted.

VARIETIES.

The following notes on the varieties raised for '91 give character of the eyes, color and measurement in inches of two average samples of each.

Several of the varieties raised had occasional specimens that measured more than those given in the table.

NAME.	Eyes.	Color.	Measure - Inches.
1 Stray Beauty.	Rather deep	Red	3x2¾ 3x2
2 Dictator.	Near to surface	Tinge of yellow	3½x2½ 2½x2½
3 Summit.	Near to surface	White	5x2 4¼x2¼
4 White Star.	Small, near to surface.	White	6x2 4x2
5 Queen of the Valley.	Few, small, near to surface	Tinge of red	3½x2½ 4x3
6 Mullally.	Surface	White	3x2¾
7 Green Mountain.	Medium depth	White	5x3 3½x3
8 Early Mayflower.	Small, surface	White	5x2 4x2
9 Crane's Extra Keeper.	Few, surface	Tinge of yellow.	3x2½ 4x3
10 Northern Spy	Medium depth	White	5 x3 3½x2½
11 Early Market	Large	Red	4x2½ 3x2½
12 Early Rose	Mostly surface	Tinge of red	5¼x2 4x2¼
13 Rough Diamond	Near to surface.	Brown	3x2 3x2½
14 Ross			
15 Early Sunrise	Near to surface	Tinge of red	5x2½ 3¾x2¼
16 Morning Star	Small, surface, or slightly raised.	White	4x2¾ 5x2
17 Fearnaught	Surface	White	6x2 4½x1¾
18 Vanguard	Large, medium depth.	White	4½x2 3½x2
19 Triumph	Good size, surface	Red	3x2½ 2½x2½
20 Early Ohio	Small, surface	White	4½x2 6x2

	NAME.	Eyes	Color.	Measure—inches.
21	St. Patrick	Near to surface	White	5¾x2
22	Beauty of Hebron	Large, medium depth	Tinge of red	3½x1½ 4½x2
23	Pearl of Savoy	Large, medium depth.	Tinge of red	5x2½ 4x2
24	Governor Foraker	Rather large, near to surface	White	4x2 5x2
25	Princess	Good size, medium depth	Tinge of red	4½x2 3½x2
26	Monroe Co. Prize	Medium size, surface	White	3x2¼ 6x2¼
27	Howe's Premium	Few, large, surface	White	4x2¾ 3x3
28	Minister.	Small, medium depth	White	2⅓x2 3x2¼
29	Bill Nye.	Large, surface	White	4x2 4x2
30	Polaris	Few, near to surface	White	3¾x2¼ 3x2½
31	Vick's Perfection	Medium to large	Tinge of yellow	4x2 4½x2½
32	Roanoke	Medium depth	White	3½x2 3x3½
33	Nott's Victor	Medium depth, mostly surface	White	3x2 3x2
34	White Flower	......	......	......
35	Six Weeks	Good size, medium depth	Tinge of red	3½x2½ 3x2½
36	Champion	Surface, few	White	3½x3 4x2½
37	Thorburn	Medium depth	Tinge of yellow	4x2¼ 3x2
38	Winner	Surface, portion raised	Tinge of yellow	6½x2 3½x2½
39	Charles Downing	Near to surface	White	4x2 3x2½
40	Jumbo.	Few, near surface	Tinge of yellow	3½x3 3x2½
41	White Elephant	Large, near surface	White	4x2½ 3x2
42	Snow Flake	Rather large, near to surface	White	5x2½ 5x2
43	Empire State	Near to surface	Tinge of yellow	4x2½ 4x2
44	Pride of the West	......	......	2½x3¼ 3½x3
45	Delaware	Medium for size and depth	White	4½x2½ 4x2½

NAME.	Eyes.	Color.	Measure—inches.
46 Clark's No 1	Few, near surface	White	3½x3 3x2½
47 Early Marine	Numerous, large, surface	Tinge of red	5x2 4x2
48 Brownell's Best	Medium size, surface	White	3¾x2¼ 3½x2½
49 Early Durham	Medium depth	White	3½x2 3x2½
50 Finch's Perfection	Near to surface	Tinge of red	3x2 3½x2½
51 Centennial	Few, surface	Splashes of blue.	3¼x3 2½x3
52 Potentate	Few, near to surface	White	3½x2½ 2½x2½

HARVESTING.

The 52 varieties grown on quarter-acre plats were dug on October 13th and 14th.

In sorting and weighing potatoes classed as small, an average sample measured 2½x1¾ inches, and weighed 2½ ounces.

The same basis of sorting was followed with the varieties grown on the half-acre plats. As previously noted, 54 hills were planted of each variety.

The following table gives the number of hills germinated, weight of large and small potatoes, total and calculated yield to the full stand of 54 hills.

NAME	DATE PLANTED.	NUMBER OF EYES.	DATE OF HARVEST.	Hills germinated.	LARGE.		SMALL.		TOTAL.		Calculated yield to full row of 54 hills.	
					Lbs	Oz	Lbs.	Oz	Lbs.	Oz.	Lbs.	Oz
1 Stray Beauty..............	April 30..	Two eyes...	October 13...	38	54	2	10	8	64	10	91	13
2 Dictator	"	"	"	48	88	2	13	....	101	2	113	12
3 Summit	"	"	"	42	87	9	21	....	108	9	139	9
4 White Star.....	"	"	"	49	124	12	19	....	143	12	158	6
5 Queen of the Valley.	"	"	"	36	63	6	9	....	72	6	108	9
6 Mullally	"	"	"	45	85	....	26	....	111	....	133	4
7 Green Mountain	"	"	"	40	112	....	9	....	121	...	163	5
8 Early Mayflower................	"	"	"	33	41	4	15	....	56	4	92	..
9 Crane's Extra Keeper.	"	"	"	17	25	12	4	....	29	12	94	8
10 Northern Spy..................	"	"	"	45	80	14	7	..	87	14	105	7
11 Early Market..................	"	"	"	46	43	4	8	8	51	12	60	12
12 Early Rose....................	"	"	"	37	65	12	26	8	92	4	134	10
13 Rough Diamond................	"	"	"	41	56	7	26	....	82	7	108	9
14 Ross.........................	"	"	"	10	.....	....	.....	....	22	8	121	8
15 Early Sunrise.................	"	"	"	42	87	4	17	...	104	4	134	....
16 Morning Star..................	"	"	"	53	156	15	16	...	172	15	176	3
17 Fearnaught....	"	"	"	47	122	...	18	8	140	8	161	6
18 Vanguard	"	"	"	33	39	12	14	...	53	12	87	15
19 Triumph..............	"	"	"	21	12	12	4	....	16	12	43	1
20 Early Ohio................ ..	"	"	"	45	53	4	12	....	65	4	78	5
21 St. Patrick	"	"	"	38	89	13	13	....	102	13	146	1
22 Beauty of Hebron..............	"	"	"	39	35	4	36	...	71	4	98	10
23 Pearl of Savoy........	"	"	"	42	59	4	17	....	76	4	98	....
24 Governor Foraker	"	"	"	54	88	12	17	....	105	12	105	12
25 Princess..................	"	"	"	33	36	4	12	....	48	4	78	15

26	Monroe Co. Prize	April 30	Two eyes	October 13	48	92	12	11	8	104	4	117	4
27	Howe's Premium	"	"	"	51	42	12	14	....	56	12	60	1
28	Minister	"	"	"	49	43	4	19	....	62	4	68	9
29	Bill Nye	"	"	"	54	122	..	10	8	132	8	132	8
30	Polaris	"	"	"	54	62	4	24	8	86	12	86	12
31	Vick's Perfection	"	"	"	50	75	12	15	...	90	12	98	....
32	Roanoke	"	"	"	51	44	4	21	8	65	12	69	9
33	Nott's Victor	May 5-6	"	"	52	51	12	22	....	73	12	76	9
34	White Flower	"	"	"	54	110	..	36	8	146	8	146	8
35	Six Weeks	"	"	"	51	44	12	14	8	59	4	62	11
36	Champion	"	"	"	38	53	4	19	..	72	4	102	10
37	Thorburn	"	"	"	51	61	4	28	8	89	12	95	1
38	Winners	"	"	"	53	127	12	23	8	151	4	154	1
39	Charles Downing	"	"	"	48	63	4	19	8	82	12	93	....
40	Jumbo	"	"	"	49	91	10	16	8	108	2	119	2
41	White Elephant	"	"	"	51	111	12	36	....	147	12	156	6
42	Snow Flake	"	"	October 14	53	101	11	35	...	136	11	139	4
43	Empire State	"	"	"	52	136	1	22	....	158	1	164	2
44	Pride of the West	"	"	"	54	99	4	21	...	120	4	120	4
45	Delaware	"	"	"	46	101	4	21	..	122	4	143	8
46	Clark's No. 1	"	"	"	54	39	12	25	8	65	4	65	4
47	Early Marine	"	"	"	42	63	12	18	8	82	4	105	12
48	Brownell's Best	"	"	"	47	42	4	20	....	62	4	71	8
49	Early Durham	"	"	"	37	46	4	27	....	73	4	106	14
50	Finch's Perfection	"	"	"	50	25	12	21	...	46	12	50	7
51	Centennial	"	One eye	"	38	41	....	6	8	47	8	67	8
52	Potentate	"	"	"	57	38	9	14	8	53	1	50	4

DATA ON POTATO CULTURE FURNISHED BY FARMERS.

To get the methods of farmers, who are raising potatoes in quantity, the following list of questions was sent out:

The name of each and his answers, as sent in, are given.

1. What time of year do you plow land for potatoes?
2. How deep do you plow?
3. What kind of fertilizer is used?
4. Do you use a land roller?
5. What kind of a harrow is used?
6. How do you mark ground for planting?
7. Do you use the best potatoes for seed?
8. What size are potatoes that you plant?
9. Into how many pieces do you cut potatoes for planting?
10. How far apart do you place the rows?
11. Do you plant a single piece of seed to each hill?
12. Distance between hills?
13. How deep do you plant?
14. How do you cover seed?
15. What style and make of cultivator do you use?
16. How often do you irrigate; total number for season?
17. How do you dig the crop?
18. As a general rule at what time of year do you get the best prices for potatoes?
19. What has been the average price for the last five years?
20. What market do you prefer?
21. What kinds of potatoes do you prefer for cooking or market?
22. What kind of soil gives best results?
23. Why do you prefer potato raising for a special crop?
24. How many tons of potatoes did you raise in 1890 and 1891?
25. What rotation of crops do you use?

HON. H. H. SPRINGMEYER, GENOA.

1. In the spring of the year.
2. About ten or twelve inches deep.
3. Barnyard manure, if any.
4. A common two-horse roller.
5. A forty-two toothed wooden harrow.
6. Using a double furrow plow, plowing two furrows four inches deep at a time.

7. Use the best potatoes for seed.
8. Do not plant whole potatoes.
9. Two or three pieces.
10. Three feet, six inches.
11. Plant one piece to each hill.
12. Fifteen inches between hills.
13. Four inches deep.
14. With a one-horse garden plow.
15. "Iron Age" horse hoe.
16. Three times.
17. Plow out with a potato plow.
18. In August.
19. Seventeen and one-half dollars ($17.50) per ton.
20. San Francisco market.
21. Early Rose and Burbank.
22. Sandy loam; new sagebrush land.
23. It is profitable and clears the soil of weeds.
24. Do not know.
25. Barley, wheat, oats, potatoes and barley again.

HON. H. F. DANGBERG, CARSON.

1. Spring.
2. Medium depth.
3. None.
4. Yes.
5. Old style.
6. With furrow plow, two shovels three feet apart.
7. No.
8. Just above smallest; selected.
9. Do not cut.
10. Three feet.
11. Yes.
12. Sixteen to eighteen inches.
13. About six inches.
14. Plow under, then roll.
15. "Acme" and "Iron Age."
16. Three or four times.
17. With potato diggers.
18. January and February.

19. Eighteen dollars per ton.
20. Sacramento.
21. Snowflake, medium sized, smooth, oblong, white.
22. New sandy loam, sagebrush.
23. ———
24. In 1890, three hundred tons; 1891, seventy-five tons.
25. No special.

Remarks—It is often advisable when planting potatoes in sandy soil, especially when dry, to give land an irrigating before planting. A general good time for planting in this section is about the 25th of May, as it fits in well with other spring work and secures the plant from May and June frosts, and with proper attention has plenty of time to mature.

MR. HARRY BARRETT, MASON VALLEY.

1. Plow in March.
2. Plow ten inches.
3. Manure from cattle corral.
4. Use no roller.
5. No harrow.
6. Plant with a plow. Turn three furrows the same way and then plant or drop the first. In this way you open one as you go south, and cover one as you go north, therefore you loose no time for dropper or team.
7. Always use the best for seed.
8. About the size of a goose egg.
9. Plant them whole.
10. Three feet.
11. Yes, single piece.
12: Eighteen inches from row to row.
13. Six inches apart.
14. ———
15. Ordinary cultivator.
16. So as to keep the soil moist.
17. With a Peerless potato digger.
18. February and March.
19, Twenty-four dollars ($24) per ton.
20. California and the Eastern States.
21. Pride of America.

22. Sandy loam.
23. Because there is more money in it.
24 1890. two hundred and fifty tons ; 1891, two hundred tons.
25. Soil is good for four crops.

MR. J. W. ROBINSON, CARSON.

1. In the fall and again early in the spring.
2. About nine inches.
3. Generally horse manure.
4. If the land is rough and lumpy, I do.
5. An iron harrow.
6. With a common twelve-inch plow.
7. Always the best.
8. From the size of a hen's egg to full size.
9. Those of the size of a hen's egg may be split lengthwise; large ones may be cut down to not less than two eyes in a piece.
10. From 28 to 30 inches.
11. Yes, a single piece.
12. From 10 to 12 inches.
13. About six inches after the ground is leveled.
14. With a common twelve-inch plow.
15. A one-horse iron cultivator.
16. As often as the ground becomes dry, and not until it is getting somewhat dry. A person must be governed by the land and also by the season. Too much irrigation is more injurious to the crop than somewhat too little; sound judgment has to be used in regard to it. On an average about once a week up to September 1st, or sometimes to the 8th.
17. First by the use of a Monitor potato plow ; then second by raking them out with six-tine iron potato hooks.
18. Usually in the spring, but it differs in some years.
19. About 1¼ cents per pound.
20. A wholesale market which we find sometimes in California.
21. For early potatoes the Early Ohio, and for late potatoes, Burbank, Snowflake and the Peerless.
22. A sandy loam.
23. Because they give better returns per acre than hay or grain.
24. In 1890 about 175 tons ; in 1891, about 100 tons.

Mr. Robinson gives as date of planting from the 10th to the 24th of May. In a second letter gives his method of covering seed as follows: I throw a furrow out, plant the seed and then plow the same furrow back again on the seed, which leaves the ground in ridges. After planting I level by the use of a harrow.

MR. A. L. HERBOLD, MASON VALLEY.

1. In April.
2. Six inches.
3. Stable manure.
4. No.
5. Diamond harrow.
6. With a six-inch garden plow.
7. Yes.
8. Size of a hen's egg or smaller.
9. If large potatoes cut in enough pieces so as to leave two or three eyes on each piece.
10. Two feet apart.
11. One or two.
12. Fourteen or sixteen inches.
13. Six inches.
14. With a plow.
15. I use a shovel plow.
16. Four to six times; it depends on the season.
17. With a potato digger.
18. Early in the fall or late in the spring.
19. About eighteen dollars per ton.
20. I prefer Virginia market, if any.
21. Early Rose or Burbank seeding.
22. Sandy loam.
23. They yield more to an acre with less expense.
24. Twelve tons to the acre,
25. Wheat or corn is best after a potato crop.

BLIGHT.

A number of the varieties raised at the Station grounds were affected with what seems to be a blight. The leaves first showed small brown spots. These increased till in some instances the entire top was dead and brittle. Some of the tubers were more or less decayed when harvested. Bordeaux mixture, of which we have made some use, is widely recommended. The discarding of diseased seed and use of preventatives early—perhaps before blight appears, if there is good reason to expect it—will doubtless do much to eradicate the disease.

Various forms of potato disease are reported from the east, and even Sir John Bennet Lawes, with an experience extending over half a century, who is supposed to come as near controlling all conditions affecting field experiments as it is possible for human effort to do, reports on page 30, "Rothamstead Experiments for 1891," under potatoes classed as "diseased," "5¾ cwts. to 19½ cwts. per acre," and a total yield per acre ranging from "2 tons, 5¼ cwts. to 7 tons, 11½ cwts."

SUMMARY.

1. Use the best selected seed. This does not necessarily mean a new, high priced, large-named variety, but reasonable selection will doubtless pay with potatoes the same as with stock.
2. Use preventatives early if any form of potato disease is expected.
3. The results of the trials of '91 seem to favor a covering of about five inches, rather than less.
4. The notes on the planting of the St. Patrick at 6, 9, 12, 15, 18, 21, and 24 inches apart in the row, are held until further trial can be made. They suggest the watching of the 6 and 12-inch distances.
5. For '91 seed cut to one eye produced least small potatoes. Whole potatoes produced most small ones and largest total weight.
6. No suggestions are made on cultivation for the reason that farmers who are raising from 100 to 300 tons annually are on the alert to increase the value of their crop, whether by cultivation or otherwise, just so far as the expense account will permit.

CHEMICAL SECTION.

The food value or ' eating quality'' of the potato depends mostly upon the amount of starch it contains, as this is the only nutrious element present in any considerable quantity.

As the dry matter of the potato is about two-thirds starch, it serves as a rough index of the quality.

The most important uses to which the potato is put are, in the order of their importance, food for man and stock, manufacture of starch, and the distillation of liquor. As all of these uses depend directly upon the starch content of the potato, efforts should be directed, as far as possible, to bring about those conditions favorable to starch production.

As a food potatoes are not as nutrious as is wheat. It is calculated that 100 parts of wheat flour, or 107 parts of the whole grain, are equivalent to 613 parts of potato. This lack of nutritative value of potatoes as compared with wheat, may be attributed to the small amount of nitrogenous matter present in the potato, there being, on an average, but 2 per cent., while in wheat there is about 14 per cent.

The ash of the potato contains, on an average, 59.80 per cent. ***potash***, 19.10 per cent. ***phosphoric acid***, about 2 per cent. ***lime***, 1½ per cent. ***soda***, 4½ per cent. ***magnesia***, and a little ***sulphuric acid***, ***silica*** and ***chlorine***. From this it is readily seen that potatoes require a soil rich in ***potash*** and ***phosphoric acid***. It would seem that the best source of these plant foods is a commercial fertilizer containing them in sufficient quantities, for what is removed from the soil by continual cropping must be returned or the soil becomes barren and unproductive. It is claimed (Kentucky Ag. Ex Station, Bull No. 9,) that stable manure is detrimental to the quality of the potato.

The following table shows the amount of water, dry matter and starch found in the potatoes raised on the Station farm this year (1891).

Varieties are named in the order of the amount of starch present.

VARIETY.	Water.	Dry Matter.	Starch.
Finch's Perfection	69.89 per cent.	30 11 per cent.	23.03 per cent.
Queen of the Valley	70 04 per cent.	29.96 per cent.	22.95 per cent.
St Patrick	69 89 per cent.	30.11 per cent.	21.59 per cent.
Green Mountain	71.10 per cent.	28 90 per cent.	21.40 per cent.
Triumph	73.09 per cent.	26.91 per cent.	19 41 per cent.
Early Rose	73.90 per cent.	26 80 per cent	19.33 per cent.
Brownell's Best	73.92 per cent.	26.08 per cent.	18.83 per cent.
Summit	75.42 per cent.	24.58 per cent.	18.78 per cent
Monroe Co. Prize	74.02 per cent.	25 98 per cent.	18.66 per cent.
White Star	74 75 per cent	25.55 per cent.	18.50 per cent.
White Elephant	74.76 per cent.	25 24 per cent.	18.49 per cent.
Winner	74 06 per cent.	25.94 per cent.	18.45 per cent.
Governor Foraker	74.20 per cent.	25.80 per cent.	18.38 per cent.
Empire State	74.24 per cent.	25 76 per cent.	18 24 per cent.
Pearl of Savoy	74.72 per cent.	25.28 per cent.	17.88 per cent.
Dalovis	75 94 per cent.	24.06 per cent.	17.68 per cent.
Vick's Perfection	75.70 per cent.	24.30 per cent.	17.50 per cent.
Charles Downing	75.07 per cent.	24.93 per cent.	17.45 per cent.
Morning Star	75.04 per cent.	24 96 per cent.	17.23 per cent.
Early Mayflower	76 57 per cent.	23.43 per cent.	17.12 per cent.
Beauty of Hebron	76.52 per cent.	23 48 per cent.	16.98 per cent.
Clark's No. 1	76.45 per cent.	23 45 per cent.	16.95 per cent.
Snow Flake	77.30 per cent.	22 70 per cent.	16.68 per cent.
Early Marine	77.92 per cent.	23.08 per cent.	16.54 per cent.
White Flower	77.38 per cent.	26.62 per cent.	16.42 per cent.
Crane's Extra Keeper	76.27 per cent.	23.73 per cent.	16 23 per cent.
New Champion	77.17 per cent.	22.83 per cent	16.18 per cent.
Vanguard	78.21 per cent.	21.79 per cent.	15.72 per cent.
Rough Diamond	78.35 per cent.	21.65 per cent.	15 63 per cent.
Dictator	79.25 per cent.	20.75 per cent.	15.56 per cent.
Early Market	79.70 per cent.	21.30 per cent.	15.54 per cent.
Bill Nye	77 32 per cent.	22 68 per cent.	15.50 per cent.
Early Sunrise	78.12 per cent.	21.88 per cent.	15.41 per cent.
Fearnaught	77.65 per cent.	22.35 per cent.	15.34 per cent.
Early Ohio	77.20 per cent.	22.80 per cent.	15.34 per cent.
Thorburn	78.64 per cent.	21.36 per cent.	15.16 per cent.
Princess	77.40 per cent.	21.60 per cent.	15.10 per cent.
Stray Beauty	78.82 per cent.	21.18 per cent.	14.68 per cent.
Delaware	79.46 per cent.	20.54 per cent.	14.36 per cent.
Northern Spy	81.27 per cent.	18.73 per cent.	14.36 per cent.
Six Weeks	79.57 per cent.	20 43 per cent.	14.28 per cent.
Howe's Premium	79.37 per cent.	20.63 per cent.	14.15 per cent.
Roanoke	79.32 per cent.	20.68 per cent.	14.12 per cent.
Jumbo	80.98 per cent.	19.02 per cent.	13.78 per cent.
Pride of the West	79.97 per cent.	20.03 per cent.	13.34 per cent.
Mullally	79.19 per cent.	20.80 per cent.	13.24 per cent.
Potentate	80.27 per cent.	19.73 per cent.	13.15 per cent.
Nott's Victor	80.79 per cent.	19.21 per cent.	12 68 per cent.
Centennial	81.30 per cent.	18.70 per cent.	12.42 per cent.
Early Durham	72.24 per cent.	17.76 per cent.	12.38 per cent.
Minister	80.10 per cent.	19.90 per cent.	12.32 per cent.

With few exceptions (the last fourteen varieties tabulated), the potatoes raised on the Station farm this year made quite a creditable showing. The first twenty varieties tabulated herein are of a remarbably good quality, while the next sixteen varieties average as well as most potatoes grown in the East. This speaks well for Nevada's potato crop, which should become a source of considerable revenue to Nevada farmers.

It may be said that in judging the quality of a potato by the amount of dry matter present, that a good potato should contain at least 25 per cent. dry matter; a fair potato from 21 to 23 per cent.; below this potatoes are of a poor quality.

The method for starch determination used in the above work was that of Sacchsse's, which seems to give as good results as any method in vogue at the present time, none of which completely fills the bill.

DODDER.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 15.

Reno, Nevada, January, 1892.

Agricultural Experiment Station.

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This Station is prepared to analyze and test fertilizers, soils, muck, which may be of agricultural value, gypsum, which may be useful for reclaiming alkali lands, cattle foods, water, milk and dairy products, seeds, with reference to their germinating power and purity; to identify grasses and weeds and study forage plants; to investigate the diseases of fruit and fruit trees, grains and other useful plants; to make reports on injurious insects and the most practical means of combatting them.

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Reno, Washoe County, Nevada.

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DODDER (*Cuscuta*) PARASITIC ON ALFALFA.*

This bulletin is called forth by the prevalence of various species of dodder in our alfalfa fields and on various wild plants in their vicinity. The term "dodder" is the common name applied to the several species of a genus of parasitic plants represented in all parts of the world. The species of dodder infesting our plants are mostly natives of this country, though a few have been introduced from Europe. They are flowering annual plants, having slender, leafless stems about the size of small wrapping twine. The general color of the dodder stem is from that of straw to orange, or reddish yellow. The green color common to most herbs is never seen in the stem of the dodder, owing to the fact that the plant produces no chlorophyll, to which is due in most plants not only their green color, but also their power to transform the crude materials taken from the soil into vegetable tissues. The dodder has no such power; hence the peculiarity of the life-history of these plants.

Thus the dodder is unable to provide for itself, and so is dependent upon some other plant for its maintenance. During the first stages of germination the young plantlet is self-supporting, wholly dependent, however, upon the store of nourishment contained within its seed. This consists of starch. Before germination the minute embryo† (Fig. 3, *d*, and Fig. 5, *b*) lies imbedded within a gelatinous substance of almost homogeneous structure, which occupies the same position in the seed as does the endosperm of other seeds. Here, however, the available starch is confined to the exterior of the endospermic substance immediately underlying the seed coats. When this nourishment is exhausted the young plantlet has attained a height sufficient to permit it

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* The cuts in this Bulletin are from drawings from nature by the author

† Cuscuta epithymum.—Murr.

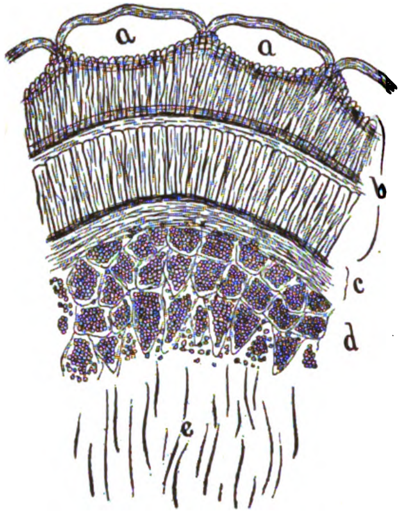

Fig. 1—Section of seed of C. epithymum. (a a) Empty external cells. (b) Outer coat. (c) Inner coat. (d) Starch granules in masses. (e) Gelatinous interior containing embryo.

to grasp and twine its stem about some plant that may be sufficiently near. This occurs providing the plant be one for which the dodder has a natural affinity. When these conditions obtain, minute haustoria (suckers) are thrown out by the parasitic dodder at points where its stem comes in close contact with that of the host.* These haustoria are minute secondary rootlets; and, like underground roots, exert considerable force in their growth. This force is sufficient to break down and push asunder the tissues of the host stem as particles of earth and pebbles are dislodged by the growth of an underground root. Thus each haustorium continues till it reaches or enters the wood of the infested plant. Its growth is then suspended and its natural function—that of transferring the nourishing sap of the host to the growing tissues of the parasite—is assumed. Fig. 2 represents, highly magnified, a longitudinal section of a haustorium projecting from a section of the parasitic stem

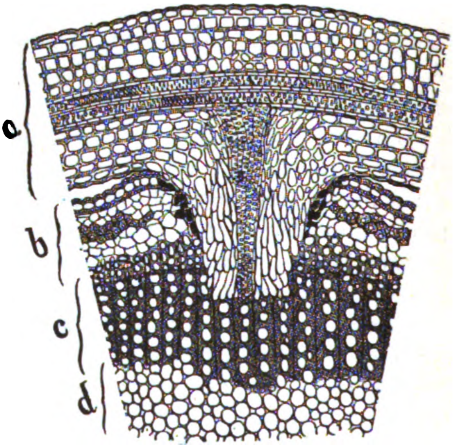

Fig. 2—A haustorium of C. epithymum. (a) Dodder stem, (b) the bark, (c) wood, and (d) pith of alfalfa stem. The haustorium is seen projecting from the dodder stem into that of the alfalfa.

It will be seen that the thick-walled quadrate cells of the stem have become elongated in the haustorium where their walls are thinner, and thus better adapted for the imbibition of the elaborated sap of the host plant. This latter is represented in the figure by a portion of the cross-section of a stem of alfalfa, *b*, *c* and

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* The plant infested by the parasite.

d; *b*, locates the bark; *c*, the wood of the stem; and *d*, the central pith. It will be observed that the haustorium has passed through the bark and partially into the wood. Its tissues are thus as intimately associated with those of its host as were they a legitimate part of the host stem. The haustoria thus serve a two-fold purpose, viz: to transfer nourishment and to maintain the plant's fixed position.

One species of dodder, Cuscuta epithymum, Murr., is found extensively in our alfalfa fields. Also it has been received at the Experiment Station with hay taken from the bale. In one such case it had completely destroyed the feeding value of the alfalfa, and formed a dense mass about the depauperate stems. Such material will be found cast aside by feeding animals.

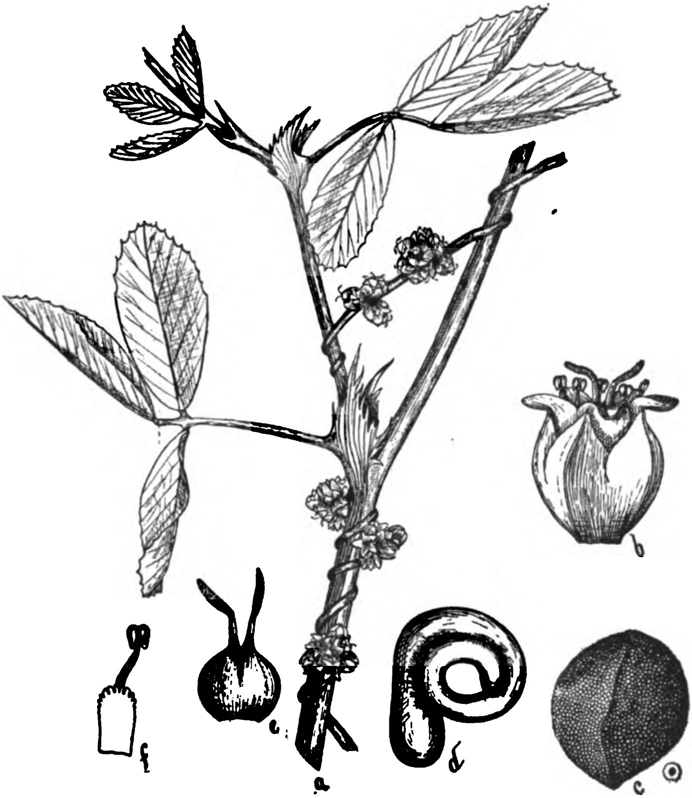

Fig. 3—(a) Stem of alfalfa bearing the twining stem of C. epithymum with its clusters of flowers; (b) an isolated flower; (c) a mature seed; (d) the embryo; (e) ovary showing characteristic stigmas; (f) a stamen with its scale.

Fig. 3, at *a*, represents a stem of alfalfa bearing a twining stem of this species of Cuscuta, of which the dense clusters of flowers are characteristic. An isolated flower, *b*, the embryo, *d*, a mature seed, *c*, and other flower organs, all belonging to this species and highly magnified, are also represented in the figure. This species of dodder is a native of Europe that has been imported in some way, probably with alfalfa seed, and, finding congenial conditions here, has thrived and is rapidly becoming naturalized.

A quantity of alfalfa seed received at the Station from Washington contained seeds of the dodder, C. arvensis, Beyrich. The first year's growth of alfalfa showed the effect of the presence of the parasite, in the yellowish-red patches of repressed plants about which the dodder formed a dense mat. The characteristic features of the flower of this species are represented at *a*, *b* and *c*, Fig. 4.

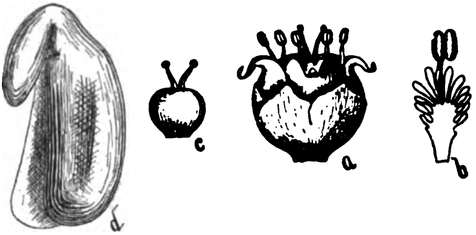

Fig. 4—(a) Flower of C. arvensis; (b) scale of same; (c) ovary of same; (d) embryo of alfalfa.

A third and exceedingly common form of dodder is Cuscuta denticulata, Engelm. which infests the "sage-brush," particularly the light-stemmed narrow-leaved shrub, Bigelovia graveolens, Gray. This plant is often so covered with the parasite that the latter's characteristic color may be recognized at a long distance. One of the flowers, with its characteristic organs, is presented in Fig. 5.

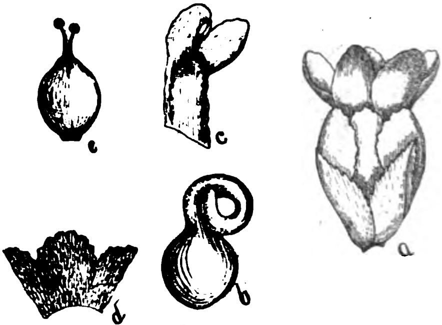

Fig. 5—(a) Flower of C. denticulata (b) embryo of same; (c) section of corolla showing scale; (e) ovary; (d) section of calyx.

The three kinds of dodder here mentioned may be recognized by the following

POPULAR DESCRIPTION OF THE SPECIES.—

Characters in common:

Stems slender, twining, leafless, light but never green in color, bearing suckers at points of contact with the host plant, dying away at base soon after germination; flowers small, less than one-eighth inch long, general color white, usually densely clustered, blooming late in the season; seeds minute, almost spherical, rough, one to four from each flower; embryo slender, coiled spirally, destitute of cotyledons.

Characters peculiar to the species:

CUSCUTA EPITHYMUM, Murr.—Flowers in dense clusters of three to ten each, stemless; calyx angular, its lobes acute; corolla lobes reflexed at extremity of calyx; stamens slightly protruding; stamen scales slightly toothed at the top; ovary nearly globular, partially divided between the styles, breaks open at maturity around the middle; stigmas linear and rough; flowers partially purple.

C. ARVENSIS, Beyrich.—Flowers in small clusters, nearly globular in general form, stems short · corolla extending well beyond the calyx; tips of corolla lobes reflexed and inturned; stamens prominent, stamen scales broad and deeply fringed; ovary globular, depressed above; stigmas rough globular masses crowning the styles; flowers white.

C. DENTICULATA, Engelm.—Flowers slightly clustered or solitary, each subtended by bracts; calyx lobes distinctly toothed; lobes of corolla rounded, slightly spreading and hiding the parts of the flower within; stamen scales toothed above and on the margins; ovary oval in outline; styles unequal in length, crowned by capitate stigmas; flowers white.

REMEDIES AND PREVENTIVES.—As the dodder is apt to spread rapidly when once established in a field, some effective remedy alone can prevent this, and at the same time eradicate the pest. Probably the most effective remedy, and one easily suggested, is that of burning the infested area. If this is done in late Autumn the best results will doubtless follow, as at this time the seeds of the dodder have but recently reached maturity and are either still in the seed capsules or simply resting on the surface of the ground. In either case a quick, hot fire, burning close to the ground, will suffice; and, if such, will probably do no injury to future crops of alfalfa from the same roots. The standing alfalfa mowed and allowed to dry for a day or two probably would furnish sufficient heat, and this, too, at the right place.

Sulphate of iron (green vitriol) if sprinkled upon the dodder is said to kill it without injury to the alfalfa.*

Better than any remedy, however, is a means of prevention. This should result from an examination of seeds used if the appearance of the dodder seed is known. At *c*, Fig. 3, is shown a single seed of dodder, highly magnified. The black dot at the right and below, inclosed within a circle, shows the natural size (about 1-25 of an inch in diameter) which will be seen to be much smaller than the average alfalfa seed. The magnified figure shows very satisfactorily the dotted appearance of the external seed coat. This is a character not at all presented by the seed of alfalfa which is perfectly smooth, and may be used with safety as a decisive character in distinguishing between the two. A hand magnifier such as ordinarily carried in the pocket is necessary in perceiving these dots. Owing to the marked difference in size between the seeds of alfalfa and dodder, a sieve of proper mesh—say twenty meshes per inch—will serve to separate the two.

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*Grasses of North America, Vol. I., Beal.

If doubt exists regarding the true character of seeds in question, they may be soaked in water till thoroughly moistened, after which they may be dissected for an examination of the contained embryos.

Fig. 4, at *d*, shows the character of the alfalfa embryo. It consists of two cotyledons, occupying the greater part of the seed, and the much smaller radicle. Quite different from this is the embryo of Cuscuta. In Fig. 3, at *d*, and Fig. 5, at *b*, are shown the embryos of the two species, C. epithymum and C. denticulata. Essentially they are the same, consisting simply of a coil of tissue somewhat enlarged at one extremity in C. epithymum and abruptly enlarged in C. denticulata. These characters are sufficiently decisive to dispel all doubt as to the seed's identity.

F. H. HILLMAN.

THE CREAMERY INDUSTRY.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 16.

Reno, Nevada, April, 1892.

Agricultural Experiment Station.

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THE CREAMERY INDUSTRY.

N. E. WILSON.

INTRODUCTION.

The great interest that is now being manifested by the farmers and others of this State in the creamery industry, and the demand for information concerning all branches of the same, has prompted the preparation of this Bulletin, which we trust may, to some extent at least, fulfill the mission whereto it is sent. It is not the object of this publication to advertise the goods of any firm or firms, but to give those who desire it full information concerning the machinery and apparatus necessary for the modern creamery, together with complete plans and specifications for a plain, substantial building and the cost of same, based as nearly as possible on the average cost of material in Nevada.

MILK.

Before taking up the subject of creameries, it may be well to present a brief statement of milk, its formation, composition and properties.

To the naked eye milk appears to be a whiteish, opaque fluid of a perfectly homogeneous character, but under the microscope its true nature is revealed. By means of this instrument milk is seen to consist of a thin watery fluid in which are suspended myriads of minute globules of varied forms, but mostly round or ovoid, and of unequal sizes. These globules are minute particles of fat and to their presence is due the butter value of milk.

Fig. 1 shows a drop of milk (somewhat diluted in order to show more clearly the relative size and shape of the fat globules) highly magnified. Careful measurements here at the Station show these globules to vary from 1-4000 of an inch to 1-1900 of an inch, thus it would take from 1,900 to 4,000 placed so their edges touch to make a line an inch long.

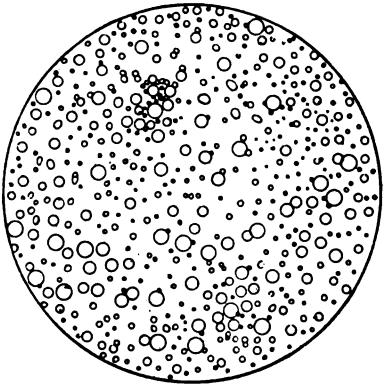


Fig. 1.

The fluid in which these fat globules appear to float consists of water holding in solution a substance called casein, which is the cheese matter of milk; sugar of milk, from which is derived the sweet taste of milk; and certain alkaline salts which give to it its flavor.

HOW IS MILK FORMED?

Milk is not a secretion from the blood, as are many of the liquids found in and exuded from the body, but is formed in the socalled milk glands through the degeneration of certain cells.

In order to understand better this process of milk formation let us refer to figures 2 and 3, which represent respectively a section of the udder of a cow and a milk gland.

The cow's udder consists of a right and left half, separated from each other by connective tissue, each half containing two milk glands, surrounded by connective tissue and covered by more or less fat tissue. Over all this is the skin.

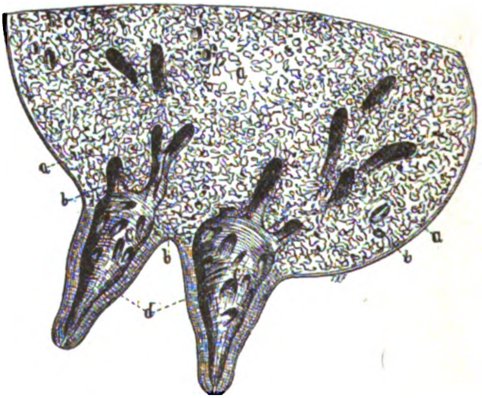


Fig. 2.

In figure 2, *a* represents the glandular moss; *b* the outlets from them; *c* the milk cistern, and *d* the teats.

The milk glands (fig. 3) consist of numerous small vesicles (or *acini*) lined with epithelial cells and supported by connective tissue. These vesicles are grouped together, forming a lobule, and these lobules again unite into a lobe. These lobes, in turn, are connected with the milk cistern by the ducts *c*.

Figure 4 shows a section through, one whole *acinus* and parts of five *acini*. *a* represents the walls of the *acini*, *b* the epithelial cells, and *c* the space in interior of *acini*.

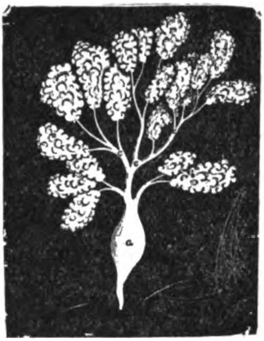


Fig. 3.

"The spaces in the *acini* of the milk glands contain originally only a small quantity of a yellowish mucus, but when conception takes place the lining cells begin to enlarge and fill with fat globules. At the same time new cells are formed and the old ones are pushed forward and fill the vesicle, and, towards the end of pregnancy, even reach the large milk ducts and milk cistern, partly separating from each other in the process. When birth takes place the cell building in the *acini* becomes more rapid and is somewhat altered in character. The previous secretions are the first to appear, forming the colostrum, which is followed in two or three days by the true milk.

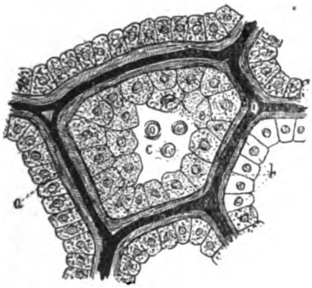


Fig. 4.

The colostrum is a thick, yellowish fluid, rich in albumen and salts, but containing little casein, and characterized by the presence of round granular bodies, which are whole cells from the interior of the *acini*. The colostrum contains also a number of fat globules. In the production of true milk, which soon follows the colostrum, a rapid formation of cells takes place in the vesicles. These cells become completely filled with fat globules and then break up entirely, setting free these globules which float in the fluid which is secreted at the same time."

Milk is a true emulsion, in which particles of fat are held in suspension by the albumen which is present, much as they are when olive oil and the white of an egg are beaten together. This process takes place very rapidly and is completed wholly in the glands, hence the resulting milk shows no trace of the process and appears to be a homogeneous fluid.

WHY DOES CREAM "RISE"?

The elements entering into the composition of milk are not of the same specific gravity (or weight), consequently when milk is "set," or left in a state of rest, rapid changes take place; the fat globules, being lighter than the other constituents, rise to the top forming a yellowish white layer known as cream. There is carried up mechanically, by those globules, a considerable amount of casein and water, thus rendering the cream more liquid or watery than it otherwise would be. Were it not for this the fat would appear in the form of pure butter and would not need to be churned to free it from these substances.

The residue from "creaming" or "skimming," known as skimmed milk, contains all of the constituents of the milk except the fat (a very small proportion of fat is left in the skim milk unrecovered. Centrifugal separation, the most satisfactory method known for skimming, leaves from 0.05 to 0.10 per cent. fat in skimmed milk). We have then, expressed diagramatically, the following:

Milk .	Cream......	Butter....		Water
		Buttermilk		
	Skimmed milk	Curd.....	Buttery and cheesey residuum	Water.
			Sugar of milk..	
		Whey....	Alkaline salts..........	

QUALITY OF MILK.

In speaking of the quality of milk we usually have reference to the per cent. of butter fat therein contained. When considering its value or quality for cheese making the casein percentage also is taken into account. Milk, it may be stated, contains on the average:

Water	87.50 per cent.
Fat	3.50 per cent.
Casein	3.75 per cent.
Milk sugar	4.50 per cent.
Ash	.75 per cent.

The composition, however, is variable. In this laboratory samples have been analyzed varying from 1.60 to 6.70 per cent. fat. Not only is there a variation in the milk of different individual animals of a herd, but the milk of the individual animals themselves varies from milking to milking and from day to day. From one day to the next it may vary as much as one-half of one per cent. in fat content.

The first milk drawn in milking is very poor in fat, while that drawn last, known as the "strippings," is very rich in fat and contains from six to twelve times as much as the first This can be accounted for on the supposition that the change which takes place when milk is "set" begins in the udder, the first milk drawn corresponding to the skimmed milk, and the last corresponding to the cream.

THE CHEMICAL CHANGES WHICH TAKE PLACE IN MILK.

Upon standing milk sours. This is due to some controlling influence which acts upon the milk sugar (*lactose*) causing it to form lactic acid. It may be the heat of the weather, condition of the atmosphere, food of the animal, or the casein may bring about this change. Recent investigations seem to prove that the conditions under which the above agents work are brought about by germs (bacteria), of which there are several species, some causing acid, some "blue milk," etc.

This lactic acid breaks up and forms butyric acid, carbonic acid and hydrogen. From the peculiar nature of the sugar in milk it can undergo all degrees of fermentation and a very palatable liquor can be made from it. The presence of these acids (lactic and butyric), is one of the greatest difficulties with which the dairymen have to contend. Butyric acid is the active agent of rancidity in butter.

VALUE OF A CREAMERY TO A COMMUNITY.

The advantages to be derived from having a well organized and successfully operated creamery in a community can hardly be over estimated.

Compared with the farm dairy, as ordinarily conducted, the creamery is far superior, and means a vast saving of time and labor, which, of course, should be counted in the cost of home-made butter. This done, the profits of the home dairy will decrease to an amazing degree. Co-operation and combination of interests in a creamery guarantee a larger quantity, from the same amount of milk, of a far better product commanding a much better price at a greatly reduced cost, besides relieving the tired farmer's wife or daughter of half the drudgery of farm life.

The development of this industry must, of necessity, create a demand for milk, which, in its turn, will call for better cows and result in a very profitable system of farming, which will do a great deal towards developing the latent agricultural resources of Nevada.

From a financial point of view, creameries are productive of great good. There are certain times in the year in all farming communities when there is little or no money in circulation. With well conducted creameries in a community there will be more or less money in circulation the year round.

It can not be expected that large dividends will be derived from the capital invested the first year. The business must have time and opportunity to grow and gain the confidence of its patrons that a constant supply of milk of a quality sufficient for profitable manufacture may be guaranteed. But, taking it all in all, it is safe to say that there is no enterprise in which the farmer can embark which will return to him in a shorter time the capital invested than the creamery business.

HOW TO ORGANIZE AND CONTROL A CREAMERY.

No enterprise, however simple, can be progressive without some guide or head, and especially is this true in the creamery industry. A perfect organization is absolutely necessary. Patrons who can furnish an abundant supply of milk must be secured, and all the minute details incident to establishing and starting a creamery must be carefully looked after.

The three principal plans of organization and control of creameries are, first, co-operation in full ; second, co-operation in part, and third, private or corporate enterprises.

CO-OPERATION IN FULL.

With this plan of organization those farmers who wish to furnish milk, combine capital and erect a plant. Thus the farmers are the sole stockholders and receive the entire profits of the business. This is a most satisfactory method and has been tried with great success in the Eastern and Southern States.

CO-OPERATION IN PART.

Next to the plan of co-operation in full the plan which gives the farmer the greatest share of the profit is that of co-operation in part. The first step necessary for the successful carrying out of this plan is to form an accurate estimate of the amount of milk that can be guaranteed for the first year. (If the enterprise is successful no trouble will be experienced in getting sufficient milk the second year). This point can not be too strongly urged, for it is of paramount importance to know something of the possible dairy resources of a community where the erection of a creamery is contemplated.

The capital necessary is to be furnished by some responsible man or company who will erect and own the plant, receive the milk (or cream) from the patrons, make it into butter, sell it at the best possible advantage and divide the net proceeds among the patrons according to the amount and quality of the milk (or cream) furnished by each. The owners of the plant obtain their share of the proceeds by deducting a certain fixed toll (amount of which should be agreed upon before operations begin), for each pound of butter made. This toll should be of an amount sufficient to cover the actual cost of operation, including wages of man in charge, wear and tear of machinery, and a fair interest on the capital invested.

It is, of course, to the interest of both owner and patron to secure a butter-maker or man in charge who is thoroughly competent and reliable.

PRIVATE OR CORPORATE ENTERPRISE.

With this plan the entire plant is built, equipped and operated by an individual or a company. The milk (or cream) is bought outright at prices regulated by the market price of butter.

This plan works quite satisfactorily in places where the conditions are favorable, yet there is more or less difficulty encountered when the state of the market necessitates a reduction in the prices paid for milk.

SYSTEMS OF OPERATING CREAMERIES.

The principal systems of operation in use in this country are

THE POOL SETTING SYSTEM,

In which the milk is carried direct to the creameries and there set in deep cans in a pool of cool water, skimmed and the cream churned. The skimmed milk and the buttermilk are turned over to the patrons, each taking an amount proportionate to the quantity of whole milk furnished by him.

To be worked on a profitable basis this system needs an abundance of ice, which, of course, must be obtained at a low rate, and there must be ready access to cold spring or well water. There are very few, if any, sections of this State where such a system is practicable.

THE CREAM GATHERING SYSTEM,

In which the patrons set the milk at their homes in cans or other vessels furnished by the creamery and sell the cream at a fixed price per standard inch. (Each standard inch of cream is considered to make a pound of butter). The skimming and gathering is done by a representative of the creamery.

Properly conducted this system can be made as great a success as it is possible to make any setting system, but like the pool setting system it is of little use in this State many things militating against its successful operation.

Of the most prominent of these may be mentioned the following:

(1.) Milk can not be handled properly under this system without ice, and few farmers would be willing to go to the expense of putting in a stock expressly for this purpose.

(2.) Very few water supplies of sufficiently low temperature are to be found, although some places situated on the foothills of the mountains may possess running water of a quite low temperature.

(3.) Numerous conditions work to effect a great variation in the creaming of milk, and consequently the value of equal measures of cream. Noticeable among these is the individuality of the different animals of a herd, their food, the time of lactation, state of the weather, season of the year and the length of time milk is set before skimming. As a result of these unfavorable conditions it is not always possible to recover all the cream, thus an actual loss is incurred.

(4.) All milk containers require the most scrupulous cleanliness, and it is practically impossible to secure uniform results among patrons in this respect.

Should anyone care to investigate these two systems further, information will be promptly given upon application to this Station.

THE CENTRIFUGAL SEPARATION SYSTEM

Is so named from the use of the Centrifugal Separator, a machine by means of which advantages is taken of the properties of centrifugal energy and of the difference in specific gravity of the elements entering into the composition of milk.

In operating under this system the milk is delivered to the creamery by the patrons and the sweet skimmed milk is taken home by them for feeding purposes, the creamery buying only the cream, or the milk is bought outright and the skimmed milk converted into cheese or fed to factory hogs.

The Centrifugal system is the most satisfactory under all conditions. It does away with trouble and expense incident to setting and skimming milk for cream, avoids the use of cold water or ice except for churning and storage, recovers all the cream regardless of the conditions of weather, time of lactation or individual breed, and in fact is effected by none of those factors so fatal to the systems of setting. Especially is the value of this system seen in the fall and winter, for about that time the cows begin to dry off and the milk is apt to become "heavy." The specific gravity of the cream becomes nearly as great as that of the milk and very imperfect creaming results. Such milk put through a separator is thoroughly skimmed and all the cream recovered. Invariably more butter is obtained by this system than any other, and in some cases it is said that the increased amount of butter thus obtained has paid for the machine in a year's time.

Briefly stated, the system which gives the largest net returns to all concerned is the one to adopt, and this, other things being equal, is found in that system, which, at a moderate cost, separates the cream most thoroughly, saves the most labor, and is least affected by changes of temperature, food or other conditions. Such a system is the Centrifugal system of cream separation.

MODERN DAIRY MACHINERY.

In no branch of the agricultural profession has there been a greater advance in methods and machinery than in that of dairying.

The modern dairy presents a vastly different aspect from that presided over by our grandfathers, and the resulting products are superior both in quality and quantity from the same amount of raw material. Foremost among the many recent improvements in dairy machinery stands the Centrifugal Separator, by means of which centrifugal energy is applied to the creaming of milk. The advantages of this system of creaming (mentioned elsewhere in this Bulletin), have been generally acknowledged.

Various forms of this machine are now on the market. The "De Laval Separator" was the first machine manufactured for this purpose and all the other machines were suggested by it and in principle are the same, the only difference being in several ways of accomplishing the same thing.

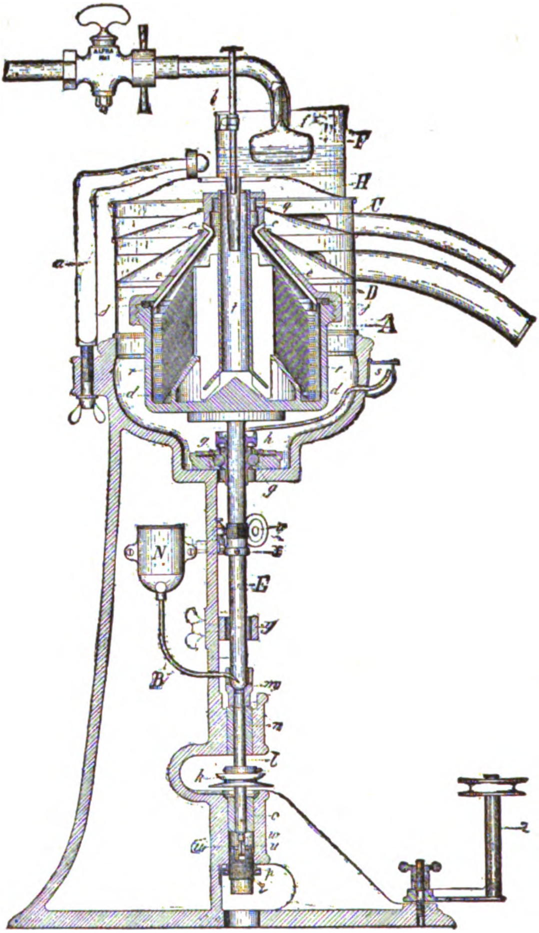


Fig. 5.

We present herewith cuts of the principal separators now offered for sale on the American market, any of which will do good work if properly handled. As very many, into whose hands this Bulletin will fall, are unacquainted with the workings of this separator, the following description and sectional view (fig. 5) of the "Alpha" De Laval is given:

In looking at the cut we see as we would the flat side of an apple cut in halves.

A represents the bowl, inside of which is a series of inclined annular rings r. After the machine has attained the requisite speed (7,000 to 9,000 revolutions per minute), the milk is let in through the tube b and cylinder l. It falls on the cone in feed cup d, flowing down the sides of the cone and up the inside walls of the feed cup, it completely fills the spaces between the annular rings r. where separation takes place. The skim milk seeks the upper side of the space and flows downward to the walls of the bowl, up the sides of which it moves, and passing through tube e, is discharged from the lower spout. The cream seeks lower side of space, and passing upward along outside wall of cylinder l, is carried out the upper spout.

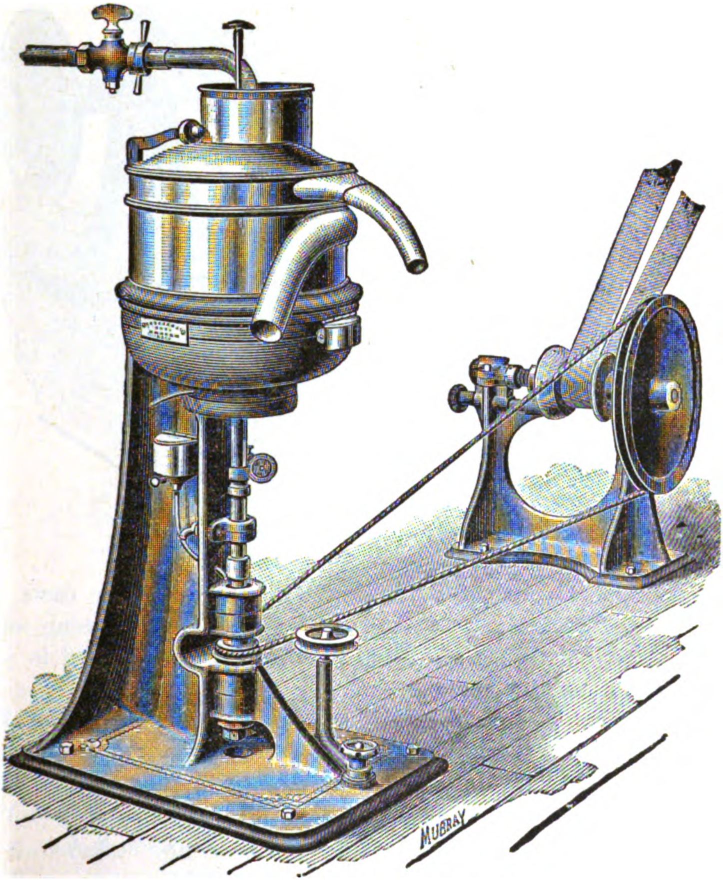


Fig 6—"Alpha," De Laval.

A word of caution to those contemplating purchasing separators may not be out of place here. Nearly all the important patents on separators are owned by one company and other manufacturers must obtain licenses to manufacture and sell or submit to prosecution. Not only

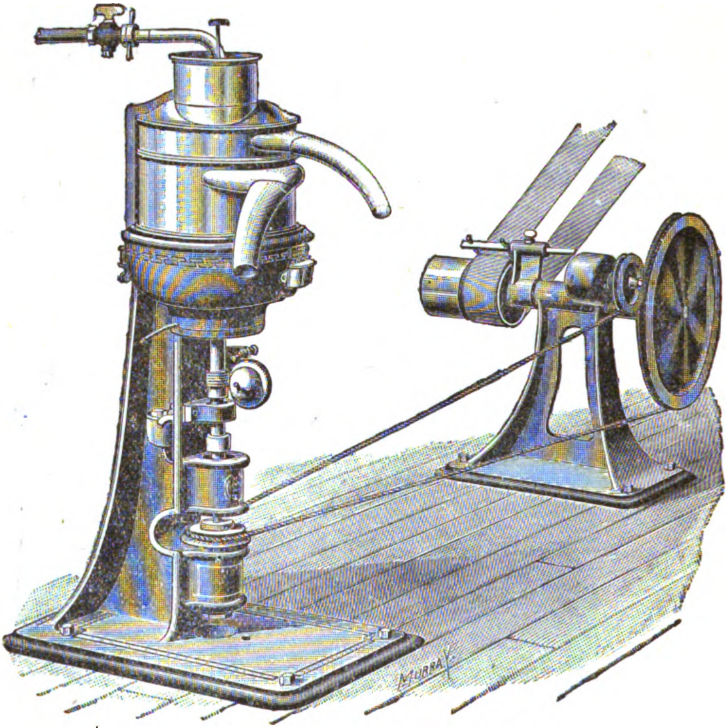


Fig. 7—"Acme" De Laval.

does this effect the manufacturers and dealers but also the users. In fact under a "process patent" the user is largely liable for using an infringing machine, hence in buying it is well to be guarded in your selection of a machine.

Figures 6 and 7 show the "Alpha" and "Acme" De Laval belt-power separators. Figures 8 and 9 show the steam turbine form of the same. The "Acme" is shown connected to vertical boiler. These machines are made by the De Laval Separator Company of New York City, and can be had on this Coast from G. G. Wickson & Co., 3 and 5 Front Street, San Francisco, Cal., the sole agents.

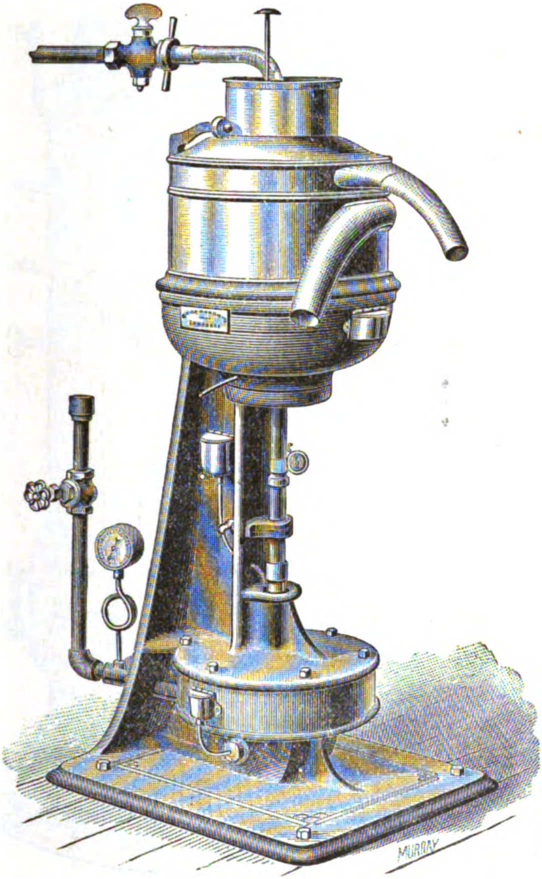


Fig 8.

A very erroneous statement has been widely disseminated to the effect that the "Alpha" De Laval can be run but a short time before it becomes necessary to stop it and clean it out, thus consuming a great deal of time. This statement, we do not hesitate to say, is without foundation, and we can cite cases disproving it, where a day's run was made with an "Alpha" without a stop, and to the last the skim milk tested as well as could be desired.

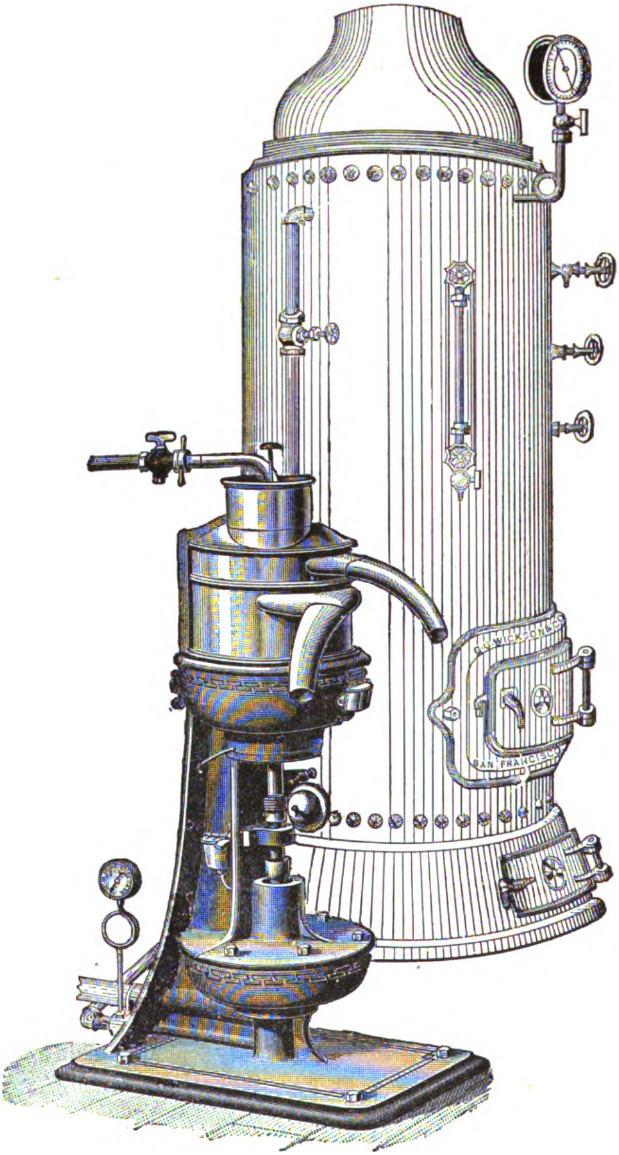


Fig. 9.

Figure 10 represents the "Sharples Improved" belt-power separator.

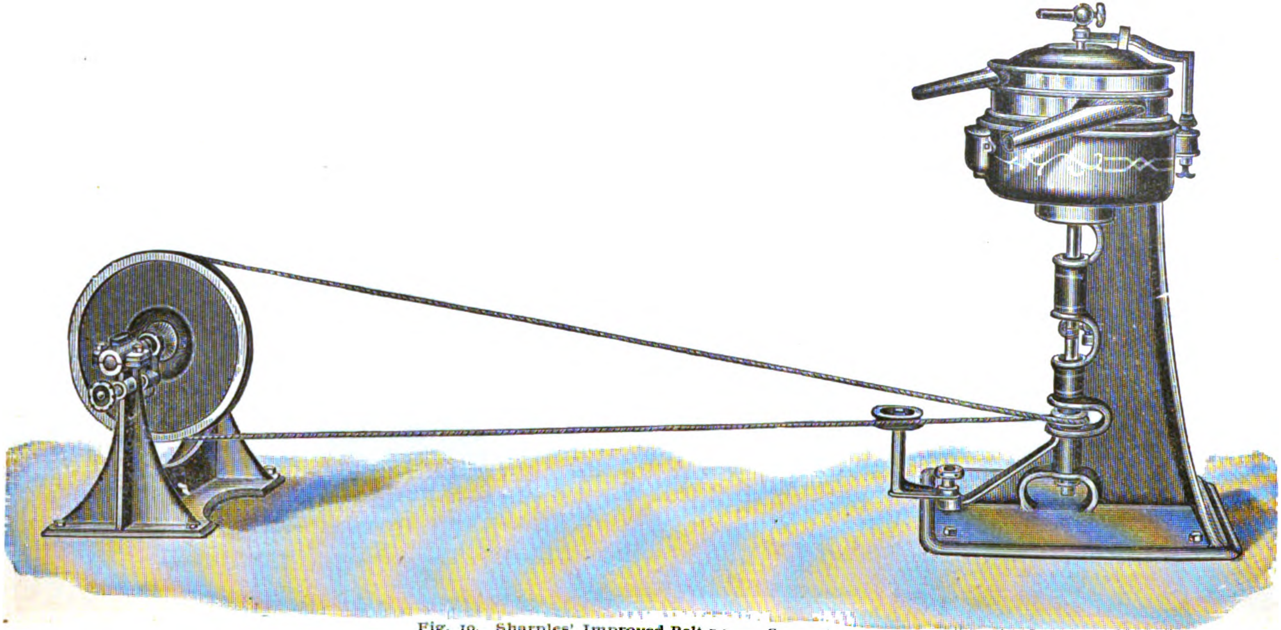


Fig. 10. Sharples' Improved Belt-power Separator.

Figure 11 shows the "Sharples Russian," in which use is made of the steam turbine principle

Figure 12 shows section of same.

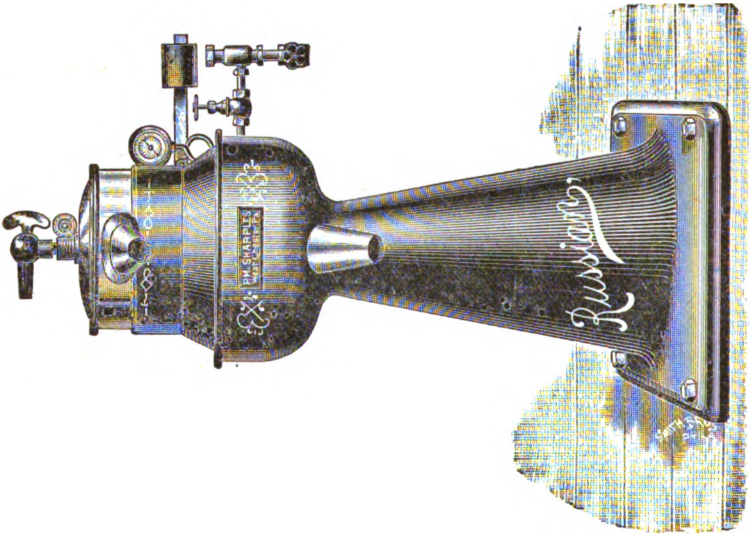


Fig. 11.

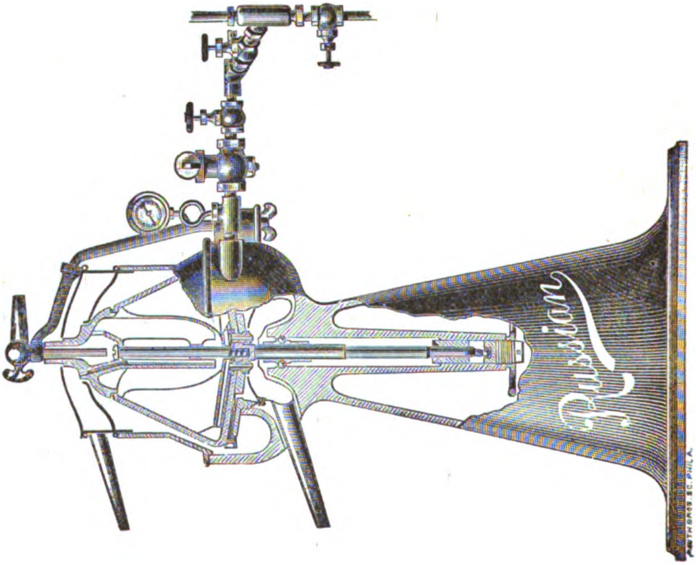


Fig. 12.

The Sharples machines are from the factory of P. M. Sharples Westchester, Pa,. and are represented on the Pacific Coast by A. J. Van Drake, San Francisco, Cal.

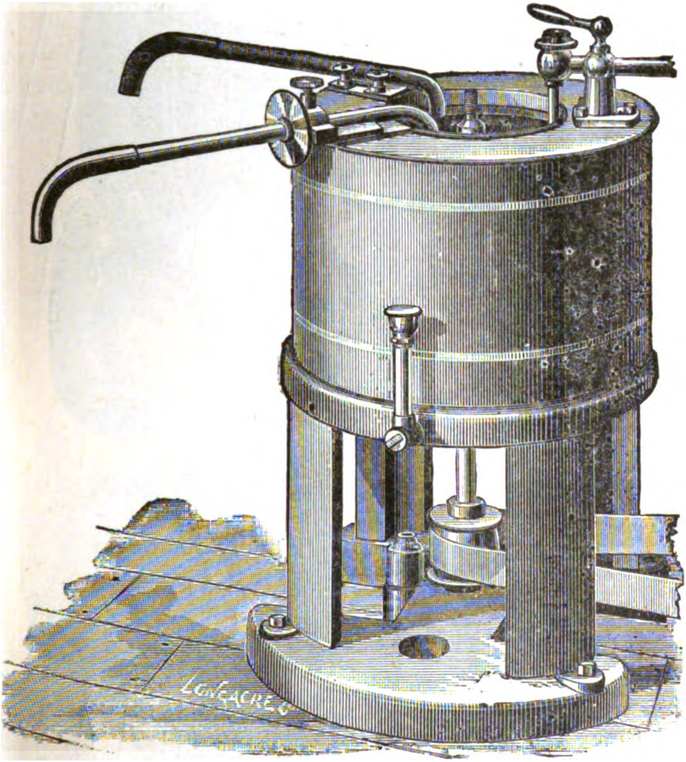


Fig. 13.

In fig. 13 we have represented the "Danish Western" Separator for sale on this Coast by G. G. Wickson & Co., San Francisco, Cal.

Figure 14 shows the "Jumbo Alexandria," made by the Davis & Rankin Building and Manufacturing Co., Chicago.

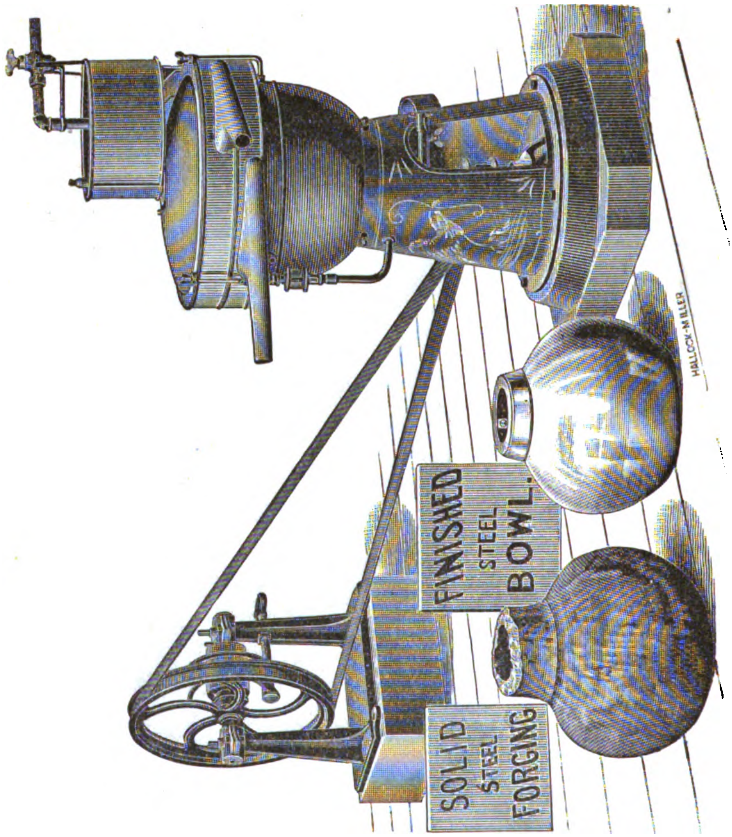


Fig. 14.

THE SEPARATOR FOR THE DAIRY.

While the advantages of this machine as a method of cream separation are widely acknowledged, the use thus far has been confined mostly to creameries and large dairies. The expense of the machines has been the most potent factor in preventing its use in small dairies.

Now, however, there is upon the market a machine known as the De Laval Baby Separator (fig 15), of comparatively low price, compact, and of a good capacity. Three hundred pounds of milk per hour can be put through, recovering all but about one-tenth of one per cent. of the butter fat. This machine is light running and is easily worked by hand. It can, conveniently, be connected with a small tread power and, as is done at the Wisconsin Experiment Station, may be worked by a young steer or bull. The exercise will do the animal good. He can be led into the tread just before milking, and when a couple of cows have been milked the machine started. The only care necessary is to supply the milk as milked. The whole lot of milk is creamed shortly after the last cow is milked. The skimmed milk, still warm, may be fed to the calves.

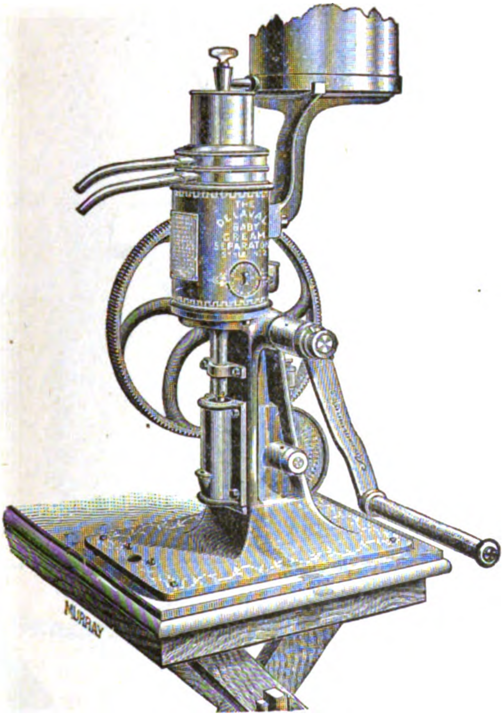


Fig 15.

Two or three farmers living near each other can club together and buy such an outfit and make use of it to their advantage, for aside from time and labor saved much more fat is recovered in this way (2 to 6 per cent. more) than by "setting."

CREAM VATS.

A very necessary as well as convenient piece of creamery furniture is the vat for receiving the cream as it runs from the separator and in which it is held and ripened for churning. These can be had in various styles of any house dealing in such goods. The cuts herein presented (figs. 16, 17 and 18), show three very popular forms of these vats.

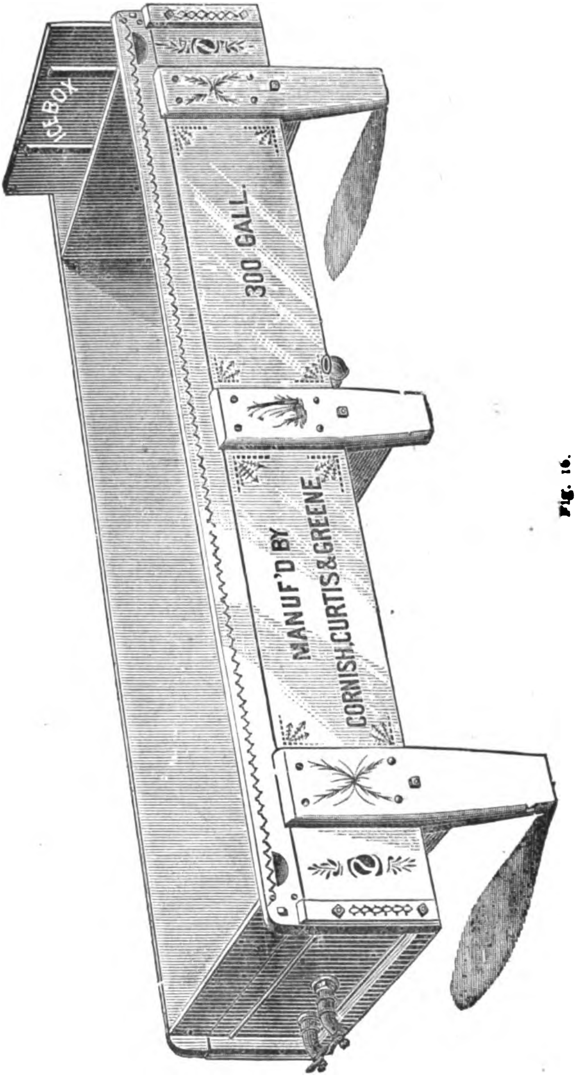


Fig. 16.

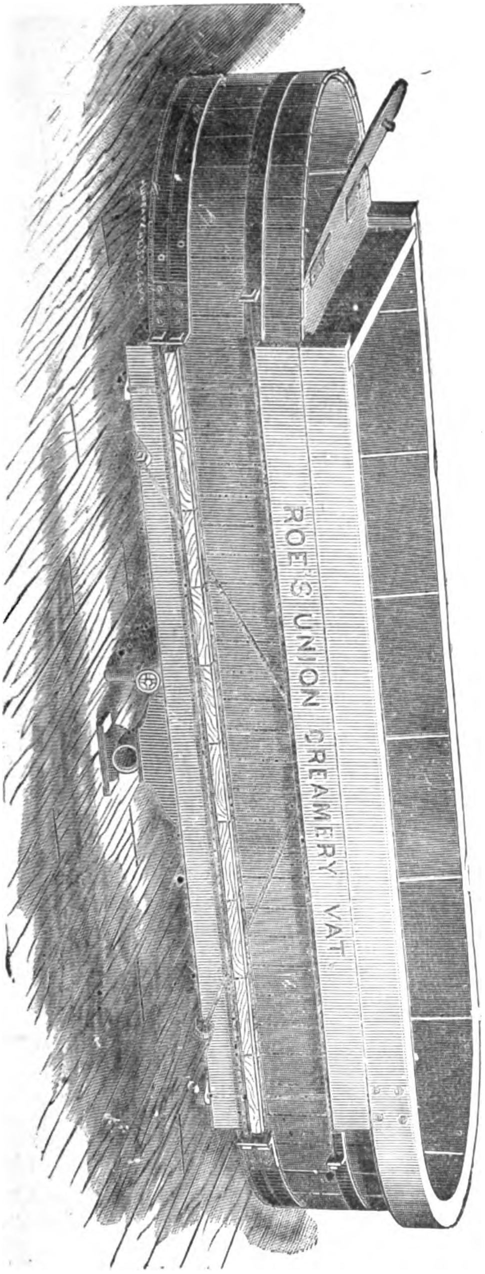


Fig. 17.

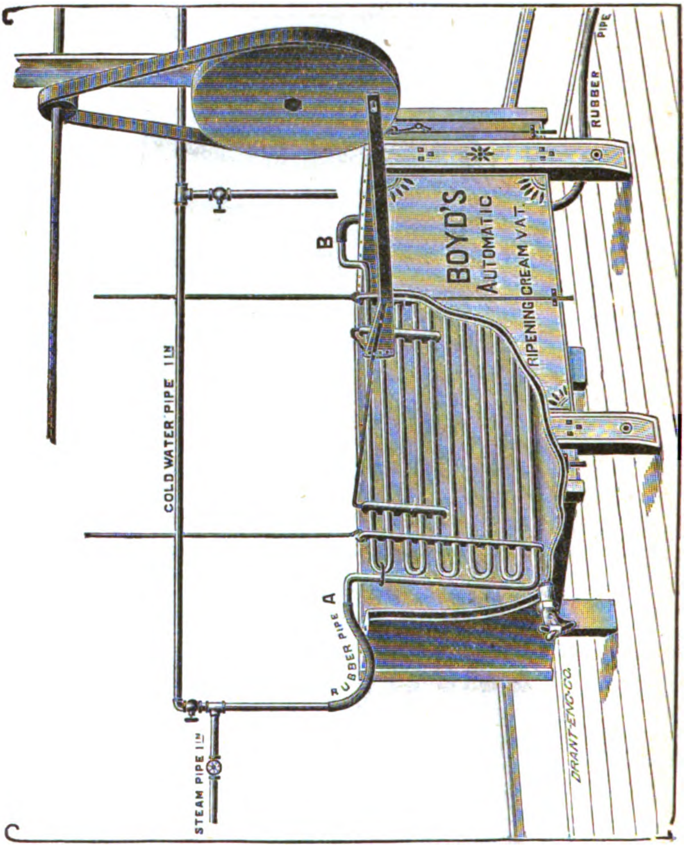


Fig. 18.

Boyd's automatic cream vat, shown in figure 18, has but lately been introduced upon this coast. The only one in use in this State has just been put into the Reno Creamery. As is seen from the figure the automatic stirrer is so arranged that cream may be heated or cooled at will by use of steam or cool water, thereby enabling one to maintain a constant temperature throughout the cream. Those who have used this style of vat speak very favorably of it. The Station will watch, with interest, the work of the one at the Reno Creamery, and will make a report on it at a later date.

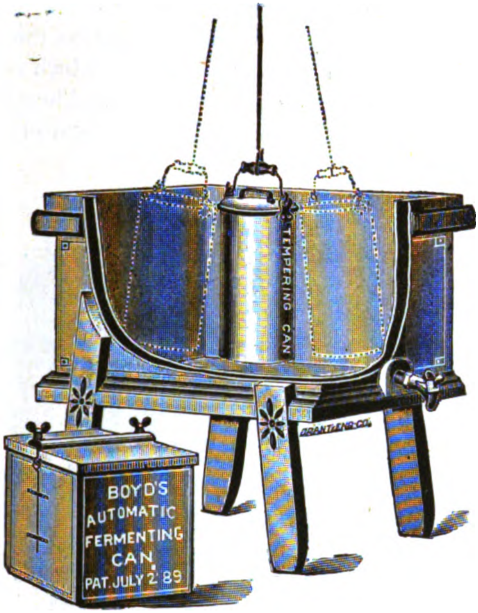


Fig. 18 a.

A very convenient form of Boyd's automatic cream vat, for use in private daries, is shown in fig. 18 a. This invention is one to be appreciated on the farm, for it is a very difficult matter to always get the cream at a proper temperature for churning. If this is not done the churn does not do its work properly, all the fat not being recovered, and the resulting butter is of poor quality, which, of course, hurts its sale.

CHURNS.

The churn is, of course, an absolute necessity with the present system of butter making. The process of churning, which may be briefly stated as simply a separation of the fat globules of cream from the liquid with which they are associated, is familiar to all who are acquainted with dairying.

The evolution of the churn is a study in itself; from the old fashioned up and down dash churn through multitudes of styles and shapes, with complicated internal mechanisms, we have come to the common box churn, with neither "dash" nor "paddles," which is conceded by nearly all experts to be the most practical yet produced. Figures 19 and 20 are good representations of this popular form of churn for factory use, made of oak.

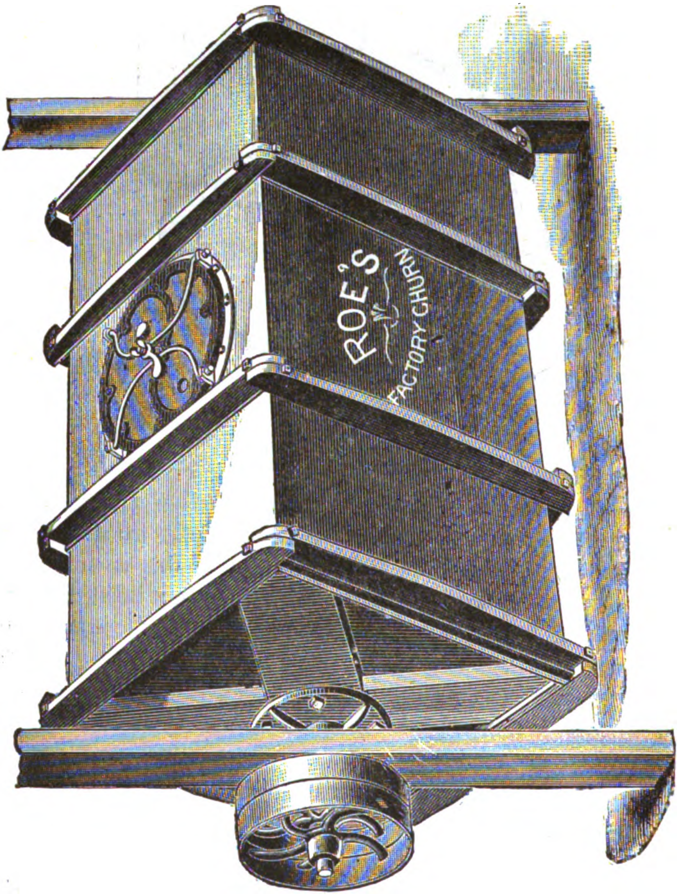
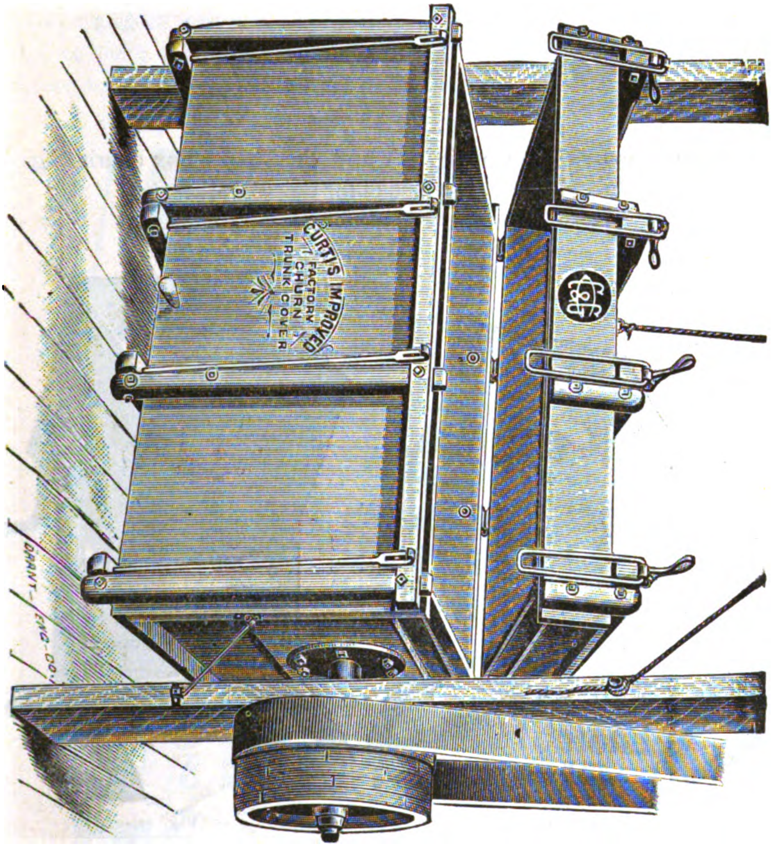


Fig. 19.


CURTIS IMPROVED
FACTORY
CHURN
TRUNK COVER
GRANT-ENG-CO.

The rectangular churn (fig 21) and the square box churn (fig. 22) will be found to give the best results for dairy work,

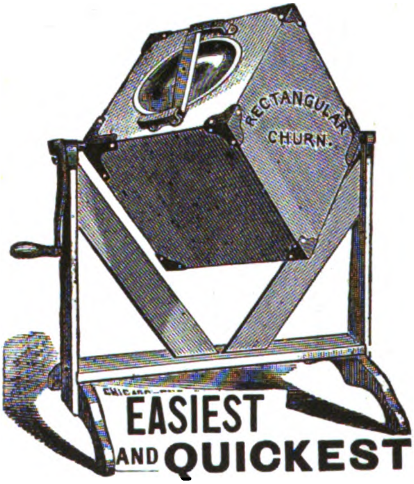


Fig. 21.

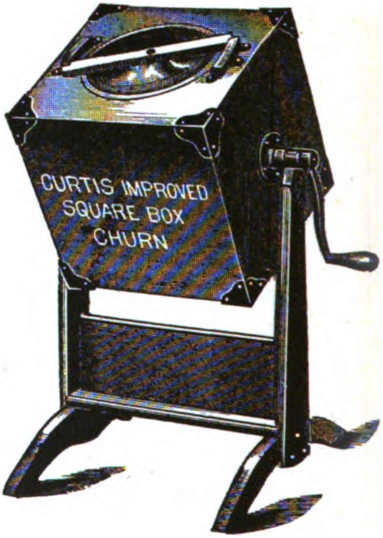


Fig. 22.

BUTTER WORKERS.

The form of butter worker best adapted to the use of the creamery is the Circular Power Worker, as shown in figures 23 and 24. Figures 25 and 26 show practical and very inexpensive forms for dairy use, or even for small creamery use. In figure 25 the sliding tray is shown removed.

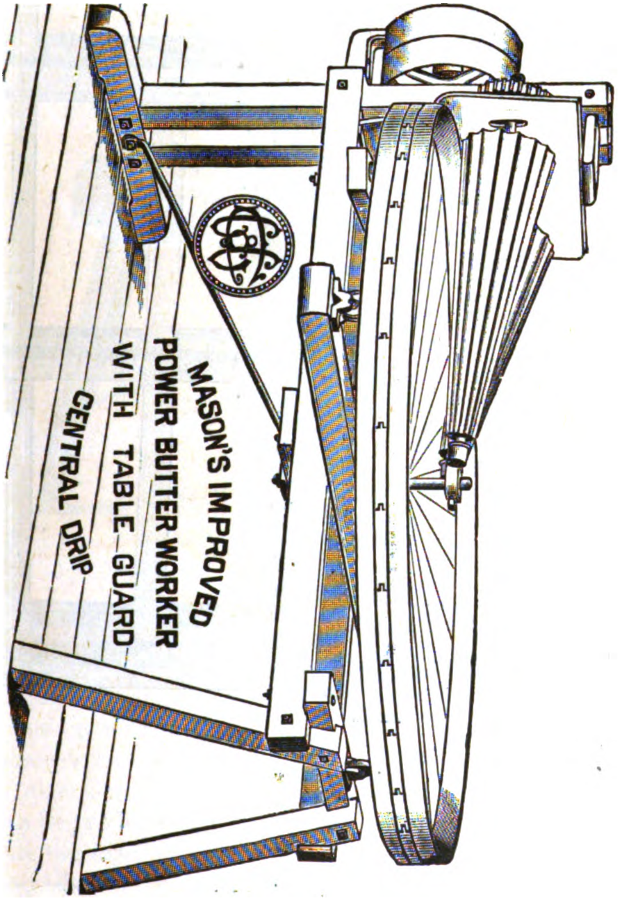


Fig. 23.

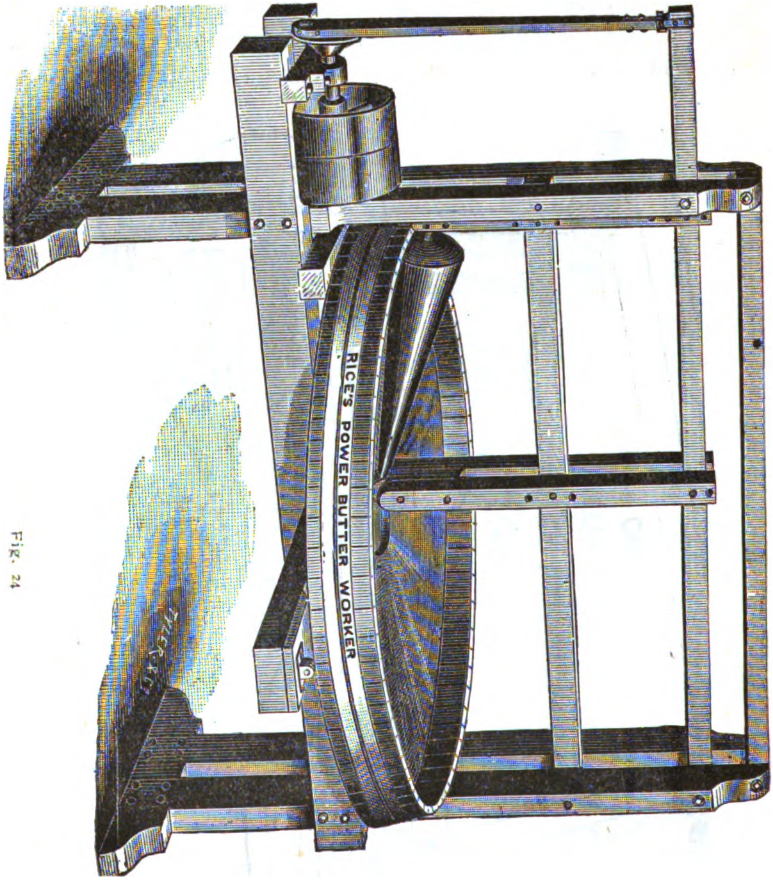


Fig. 24

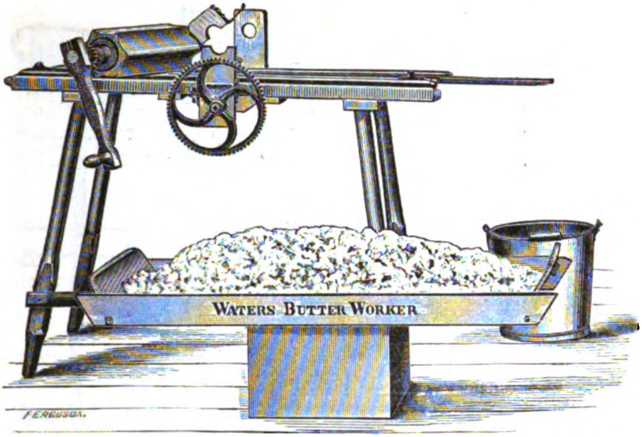


Fig. 25.

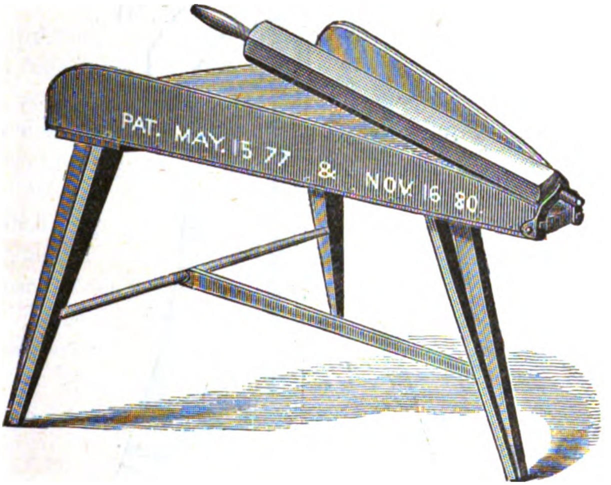

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Fig. 26. (The Eureka.)

SWEET CREAM BUTTER.

While by no means a new idea, the manufacture of sweet cream butter is a quite recent departure from the old established method of dairying in this country.

In some sections quite a market has been built up for this product, but its manufacture is, as yet, by no means general.

It can be produced by use of the churn in the usual manner, but there are two machines now upon the market which are great savers of time and labor in the manufacture of this variety of butter.

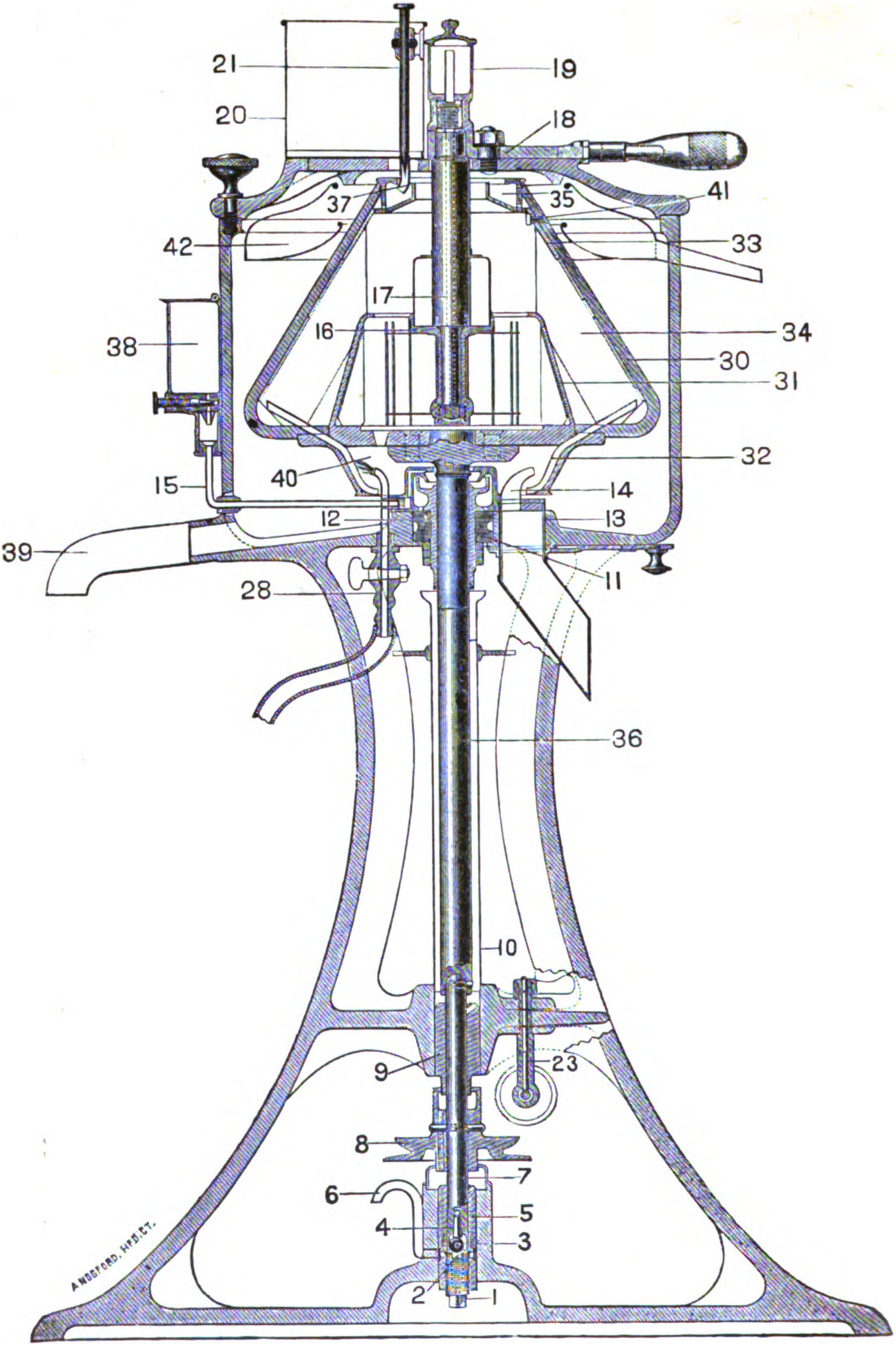
A MUGFORD, HFD. CT.

Fig. 27

The first of these to be mentioned is the "Butter Extractor," which is the invention of C. A. Johanasson of Stockholem, Sweden. The sectional view (fig. 27), shows the mechanism of the same.

In appearance the Extractor is much like the Separator, but the internal construction is quite different. In fig. 27, 30 represents the large bowl, inside of which is small bowl 31, containing a trundle wheel 16.

The machine is started, and, when the desired speed is attained, milk is let in from the receiving tank 20, through the tube 37, to the feeding rim 35. From here it flows into the bowl 30, by means of tube 33, where separation takes place, the skim milk passing out through tubes 32 and 39. The cream drops into the inner bowl 31, and is churned by the trundle wheel 16. The butter, in granular form, passes into the chamber 40, where it is washed by a jet of cold water through the faucet connection 28. It now passes through 13 and 14 out into the receiving vessel as pure, fresh butter, ready for salting and working.

This machine is so constructed that it may be run as a separator only, the cream being churned in the usual manner. For sale by Vermont Farm Machine Co., sole licensee, Bellows Falls, Vermont.

The second machine, for the purpose of producing sweet cream butter, is the "Wahlin Butter Accumulator," which, like the "Extractor," is of Swedish origin. This is a very recent invention and has been on the market but a few months. The first order was filled for Vice President Morton, for his large farm at Rhinecliff, N. Y., and is giving great satisfaction. The machine is made to fit on the bowls of all the separators now offered for sale, which makes it applicable for use in any creamery or dairy using the Centrifugal system of creaming. The cost is very reasonable, seventy-five dollars paying for its free delivery on

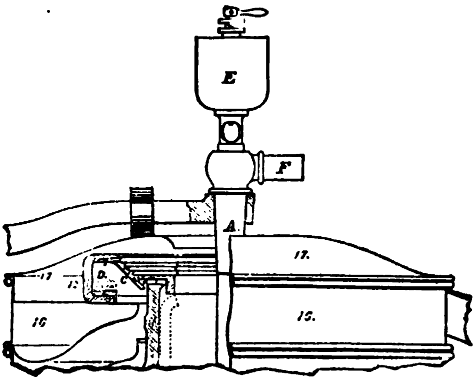

Fig. 28.

the cars at the factory. By means of this attachment any creamery-man can determine for himself the practicability of making sweet cream butter. Figure 28 shows sectional cut of this machine as attatched to the bowl of the De Laval Separator. It is placed on the neck of the bowl, to which it is fastened, and extended beyond the cream slot 1. When the separator has reached the proper speed the milk is let through the tubes F and A into the bowl, where it is separated, the skimmed milk being drawn off through the usual tubes. As the cream leaves the bowl through the regular cream slot 1, it is thrown into the annular groove 2, from where it passes into the annular groove 3, at which point it accumulates and undergoes a second separation. From this groove it passes, in a very thin layer, over the ledge into the next groove 4, and so on to the uppermost, From the last groove it passes through the orifice 7 into the chamber D, where the butter granules are finally separated from skimmed milk, or, as we can call it, the butter-milk. This latter is drawn off through the little tube 8, and the butter particles pass out through the tube 12. Both are received in the lid 16 and pass out together into the receiving vessel. The butter is now ready for draining, washing and salting, and the result is a first-class sweet cream butter. The cup E at the top is a contrivance for coloring the butter particles as may be desired.

This machine can be had of R. D. Harris, 127 West Thirty-second Street, New York City, and can be readily shipped by express, as it weighs under ten pounds.

COST OF MANUFACTURE.

The cost of manufacture varies under different circumstances. In no case will it fall below 4 cents per pound, not allowing for interest on investment, and it should not exceed ten cents per pound. Under average conditions, and with sufficient milk to run the plant to its full capacity, 5 or 6 cents per pound is a fair manufacturing cost. With only half enough milk for full capacity the cost is doubled.

PRICE OF CREAMERY BUTTER AND MARKET.

We are indebted to Mr. John H. Hegler, of the firm of Hegler, Johnson & Co., commission merchants, San Francisco, Cal., for the data given in the following table, relative to the price and number of pounds of fresh roll butter received by them each month of the four years last past.

These figures will give a good idea of what one may expect to realize from butter sales :

		1888.	1889.	1890.	1891	Average monthly price.	Total pounds received.	Amount realized therefrom.
January.	Price	45	27½	25	38	33 90		
	Pounds received	431.500	809,000	988,500	661,000		2,890,000	$979,710
February.	Price	40	24	18½	37½	30		
	Pounds received.	741 500	905,000	997,000	752,500		3,396,000	1,011,800
March	Price	27	18	17	26	22 12½		
	Pounds received	1,141,000	1,250,000	1,216,500	1,200,000		4,807,500	1,063,560
April.	Price	25	16½	16	20	19 50		
	Pounds received	1,181,000	1,465,000	1,552,500	1 714,000		5,912,500	1,152,937
May.	Price	27½	18	16	20	20 37½		
	Pounds received	1,555.500	1,658,000	1,873,000	1,610 000		6,694,500	1,363,670
June.	Price	26	19	16	22	20 75		
	Pounds received	1,147,500	1,247,000	1,280,000	1,260 000		4,934,500	1,011,572
July.	Price	28	20	16½	22½	21.75		
	Pounds received	859,000	962,500	1,174,500	1,227,000		4,233,000	910,095
August	Price	35	24	30	30	29 75		
	Pounds received	846,500	1,000,000	731,000	828,000		3,405,500	1,012,650
September	Price	35	30	30	35	32.75		
	Pounds received	443,500	590,000	573,000	555,000		2,261,500	740,641
October.	Price	36	32½	35	33	34.12½		
	Pounds received	543 500	538,500	536 000	509,000		2,027,000	691,180
November	Price	35	34	36	37	35.50		
	Pounds received	467.500	530,000	365,000	463,000		1,825,500	648,052
December	Price	37½	25	40	37	34.87½		
	Pounds received	463,500	603,000	385,000	518,000		1,969,500	689,150

SUMMARY OF TABLE.

Total fresh butter received in four years, 44,359,000 pounds; amount realized therefrom, $11,275,017; average price per pound for the four years, 25.42 cents. Besides the fresh roll butter there was received in the four years, of California packed butter a total of 7,280,050 pounds; of Eastern packed butter a total of 7,356,700 pounds.

Mr. Hegler further says: "In the matter of receipts of butter perhaps ten per cent. more is received than our figures show, that amount going to retail dealers and consumers direct. As prices are high when receipts are light, and low when receipts are large, a correct average price cannot be had by adding the price in the 48 months and dividing by 48. Such a result would be misleading. To reach a correct average price find the receipts for each month, multiply by the price for that month, find the amount realized in money, and continue doing so each month in the four years, and by dividing the total amount of money realized by the total pounds received, the true average is obtained.

"For four years together the average monthly price of butter has been: January, 33.90; February, 30; March, 22.12½; April, 19.50; May, 20.37½; June 20.75; July, 21.75; August, 29.75; September, 32.75; October, 34.12½; November, 35.50. December, 34.87½.

"You ask 'should a dozen creameries be started in Nevada could the product be disposed of in California?'

"We think, certainly, it could, and easily too. A dozen creameries would probably not receive the milk of more than ten or twelve thousand cows. In California the four leading dairy counties actually milk 74,000 cows, the entire State milking 130,000 cows. Therefore about 8 per cent. of butter would be added to our product if all your cows were new stock. But of this stock much is now turning out dairy butter, and therefore the product is simply a change from the dairy to a creamery product, the creamery very materially reducing the cost of production and largely increasing the selling price, and if *cheese is made, very largely increasing the value of the milk.

POINTS ON BUTTER MAKING FOR THE BEGINNER.

CARE OF COWS AND MILK.

No cow will give the best yield unless properly cared for. She must be well fed, have access to plenty of fresh water, receive salt regularly, and, by all means, be handled gently.

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* No mention is made of cheese in this Bulletin, as a separate bulletin on "Cheese and its anufacture" will shortly follow

If a farmer has in his employ a man who kicks a cow because she doesn't stand to suit him at milking, beats her with the fork or shovel handle, or dogs her, he will find it greatly to his advantage to dispense with that man's services. Treat the cow gently and the reward will soon be an increased flow of milk.

Milk has the property of rapidly absorbing odors and fumes, consequently should be removed from stables or yards as soon as possible.

All containing dishes should be of tin, and must be scrupulously clean. They should be thoroughly washed after each using with water in which a little soda (common sal-soda) has been dissolved ; carefully rinsed, steamed with live steam and put in sun and air to dry.

USE AND CARE OF THE SEPARATOR.

The separator in general use must be understood and handled carefully. It is a well known fact that when a body is revolved at a very high rate of speed there is a great tendency for it to fly to pieces. This is the case with the separator bowls. Most of those now in use are tested and guaranteed for a speed of 10,000 resolutions per minute. In separating a speed of from 7,000 to 9,000 is safe and insures the best results. The machine should be started and allowed to reach the desired speed before the milk is turned in. The best temperature for separating has been found to be from 80° to 85° F.

RIPENING THE CREAM.

As soon as separated, cream should be allowed to stand at about 58° to 60° F. for about twenty-four to thirty-six hours, or until it reaches the proper stage of ripeness, just on the point of turning sour. Cream should be stirred as often as possible while undergoing the process of ripening.

COLORING.

If it is desirable to use coloring it should be added to the cream in the churn in such quantities as specified in the directions accompanying each package.

Several colors are on the market, of which Hansen's, Wells, Richardson & Co's, and Fargo's are all good. The "Improved Butter Color," of Wells, Richardson & Co., is now obtainable in bulk.

CHURNING.

The best style churns for factory use are those shown in figs. 19 and 20. Never fill any churn much over half full. If cream is thick it will be found advantageous to thin with water.

Churning, to produce best results and recover practically all the fat in the cream, must be governed by the thermometer, guess work will not do. The best temperature for churning is about 56° to 60° for summer work, and about 65° for winter.

Churning should be done slowly, at moderate speed, forty-five to fifty revolutions per minute, and at first the churn should be stopped at intervals and the vent opened for the purpose of allowing accumulated gasses to escape.

Cease churning when the granules are about the size of wheat kernels. This stage of the operation can be readily detected by an expert from the sound, but to make sure of it the cover should be removed from the churn and the contents inspected. Draw off the buttermilk and remove the last traces by thoroughly washing (in churn) with pure cold water. When the water runs away from the churn *clear* the buttermilk is removed. Drain thoroughly.

SALTING AND WORKING.

Take up the butter in this form and salt at the rate of an ounce to the pound. Distribute the salt evenly through the butter and press the granules together. *Do not work.* Set aside in the cool for about twelve hours and then work *just sufficient* to insure uniformity, even distribution of salt, and the removal of surplus moisture.

Use none but the best quality of dairy salt.

PACKING.

If butter is to be packed in tubs, the tub should be placed in hot brine and allowed to soak from twelve to twenty-four hours, and before using should be scalded out with clean hot water and rinsed with cold water.

Either a layer of salt or parchment paper is placed in the bottom of the tub and the butter firmly packed. Cover the smoothed top with parchment paper or "muslin" and fill up to the cover with salt.

For immediate consumption, fancy prints, one-half pound or one pound, or plain two-pound rolls are very convenient forms and bring good prices.

CARE OF THE CHURN.

In cleaning the churn there is the sour milk and small particles of butter to get rid of. Hot water will melt the adhering butter, but coagulate the milk and glue it to the sides of the churn.

Cold water will wash away the milk but will not act on the butter. Therefore, the proper way is to first drench the churn with cold water and wash off all the buttermilk, then use boiling water or steam to remove the fragments of butter. This is to be thoroughly done and the churn again drenched with cold water and wiped dry with a perfectly clean towel.

MILK TESTING.

For years past there has been an urgent call for some means of testing the value of milk, both in the creamery and on the farm.

Method after method has been invented and placed before the public, none of which were of much practical value to the creameryman or farmer until in 1888. Prof. F. G. Short, then of the Wisconsin Station, produced the test known as "Short's Oil Test." The introduction of this test marked a new era in milk testing. It was simple, practical and quite well adapted to the use of the creameryman and farmer; its great drawback being the length of time required (nearly four hours) to make a complete test. Other tests soon followed, among which were those of Parsons, Fayler & Willard, Cochran, Patrick and Beimling, all of which have been carefully tested by the author of this Bulletin, and are practical methods for ascertaining the percentage of butter fat in milk. The last named, Beimling, stands second only to the "Babcock Test," now so widely used.

Milk testing is a necessity, and no creamery or dairy is complete without a testing outfit. Now and then persons are found who scout the idea of milk testing, but such persons are few and their prejudice is based simply upon a lack of knowledge of the methods and objects of testing.

MILK TESTING ON THE FARM.

In every herd will be found cows that are a source of profit to their owners, others that hardly pay for their keeping, and still others that are kept at an actual loss. It is money in the farmer's pocket to detect and cull out such animals, that their places may be taken by more profitable ones. Systematic testing is the best and surest means of accomplishing this end.

As has been before stated the milk of individual animals varies from milking to milking and from day to day. From one day to the next it may vary as much as one-half of one per cent. Here, too, is the milk tester of great use to the farmer in telling him exactly what his cows are doing from day to day, and in showing him the effect of food upon the production of milk.

Again, the tester is a valuable adjunct to the butter-making outfit. Few dairymen realize the amount of money they yearly throw into the swill barrel, when careful attention to the minute details and conditions governing the skimming and churning, and controlling the same by the tester, would put at least 9-10 of this money into the farmer's purse. As an illustration we cite a case from the Station records :

A farmer, who owns a large dairy herd, brought samples of the herd milk to the Station to be tested, and was asked to bring samples of the skimmed milk and buttermilk. This, he did, and upon analysis the following results were obtained :

Whole milk	4.88 per cent. butter fat.
Skimmed milk	3.00 per cent. butter fat.
Buttermilk	8.00 per cent. butter fat.

The weights of milk were not ascertained, so actual figures cannot be used in carrying out the results. However, assuming that there were 1,000 pounds of whole milk, 200 pounds of cream, 800 pounds of skimmed milk, and 140 pounds of buttermilk per week, then of the 48.8 pounds of butter fat in the whole milk only 50.81 per cent., or 24.8 pounds, were recovered in the cream. There were lost in skimmed milk each week 24 pounds of butter fat, or the equivalent of 26.16 pounds of completed butter, which, at an average price of 25 cents per pound, equals $6.54 per week, or $340.08 per year. In the buttermilk there was lost 45.12 per cent. of the fat recovered in the cream, or 11.20 pounds, the equivalent of 13.04 pounds of completed butter, which, at 25 cents per pound, equals $3.25 per week, or $169 per year, making a total loss of $509.08 in skimmed and butter milks. By proper care nearly 9-10 of this, or $458.19, can be put into the farmer's pocket instead of into the hog's stomach to make six-cent pork. It is the milk tester that shows where the loss is and the extent of it.

THE TESTER IN THE CREAMERY.

To the creameryman the tester is just as important in controlling the separator and churn as it is to the dairyman, and from a financial view it is absolutely necessary that he know just what his separator and churn are doing that he may be able to correct loss in skim and buttermilks before it becomes serious.

In buying milk it is indispensable. There is but one just method of paying for milk, and that is on the basis of its "fat content" or "butter value."

It is certainly unfair to pay the same for rich milk as for thin milk, not only to the patrons but to the creamery man. If one patron brings milk containing 3 per cent. fat, and another milk containing 4 per cent. fat, the one should receive only three-quarters as much for his milk as the other. The testing system puts each patron on his own merits and the result is a much better grade of milk is furnished, for under this system all adulterating and "watering" means a loss to the patron, whereas, when milk is bought without regard to quality "watering" is at a high premium.

THE BABCOCK TEST.*

This test, invented and given to the dairymen by Dr. S. M. Babcock, has come into such prominence, and is of such practical value in the creamery, a complete description is here given. The necessary apparatus consists of :

1. *Test bottles*, of form shown in figure 29. They should contain up to the neck not less than 40 c. c,, and not more than 45 c. c. (about 1½ ozs). Each division of the graduated scale upon the neck represents .04 c. c., and in order to facilitate the reading the neck is made of such a diameter that the marks of the scale are about 1½ millimeters apart. Five of these divisions are equivalent to one per cent. of fat when 18 gms. of milk are used in the test, it being assumed that the specific gravity of the butter fat, at the temperature at which the reading is made (about 120° F.), is 0.9. Each division on scale represents one-fifth of one per cent.

2. *Pipette for Measuring Milk.* This may be of any form, but that shown in figure 30, with a rather wide opening at the lower end to allow the milk to run out rapidly, is to be preferred. It should contain, when filled to the mark, 17.6 c. c. A pipette of this size will deliver a little less than 17.5 c. c. of milk. The quantity of milk required for the test sample of 18 gms. is 17.44 c. c., if the milk has the average specific gravity of 1.032.

3. *A Measure for the Acid.* A graduate or cylinder of glass (fig. 31), with a lip to pour from and a single mark at 17.5 c. c , is the best form for general use. In laboratories a large burette, holding 100 c. c. or 200 c. c., with marks at each 17.5 c. c. and having a glass stop-cock, may be used to advantage, but, on account of the liability of breaking, is not to be recommended in factories or private dairies.

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* Bulletin 24. Wisconsin Experiment Station.

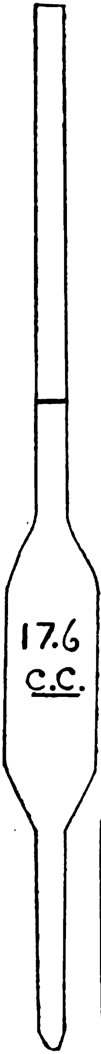

Fig. 30.

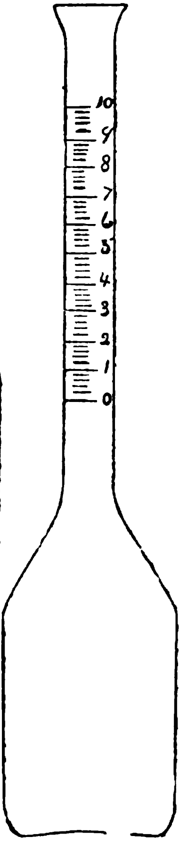

Fig. 29.

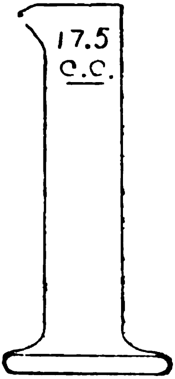

Fig. 31.

4. *A Centrifugal Machine.* Any form of centrifugal may be used with which a speed of 700 to 800 revolutions per minute may be main-

tained. Figure 32 shows a very convenient and practical form made by D. H. Roe & Co., Chicago. Figure 33 shows the same adapted to the use of power.

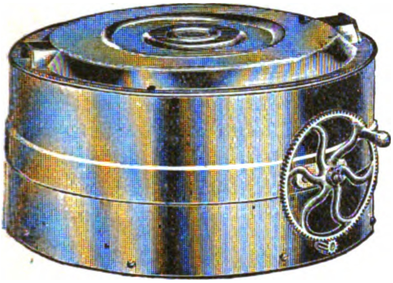

Fig. 32 (closed).

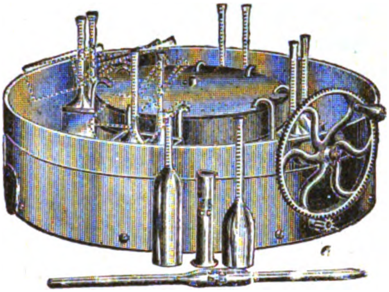

Fig. 32 (opened).

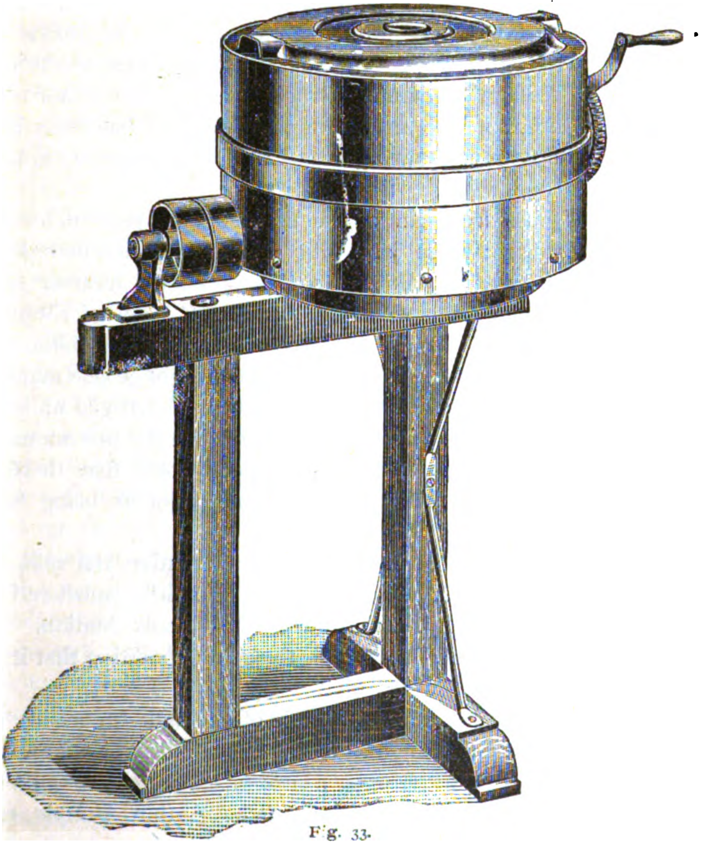

Fig. 33.

Excellent machines are made by Cornish, Curtis & Green, Fort Atkinson, Wis., and by the Vermont Farm Machine Co., Bellows Falls, Vt.

5. *A kerosene or gas lamp* for heating two or three quarts of water to boiling.

6. *Commercial Sulphuric Acid*, the ordinary "oil of vitriol" of commerce, having a specific gravity of 1.82 or about 90 per cent. pure. If only the pure acid is available, it should be diluted with water to the strength indicated.

HOW OFTEN SHALL SAMPLES BE TAKEN?

This is an important question which presents itself to the creamery-man. To insure great accuracy analyses should be made daily, but if one is pressed for time "composite samples" may be taken and analyzed at the end of the week, thus saving six-sevenths of the work incident to daily testing. This method was used by the author in his work at the Vermont Station in 1888 and 1889, and has been lately published by Prof. Patrick of the Iowa Station. The samples are taken as follows:

"Have a pint glass fruit can of the lightning jar pattern for each patron of the creamery; these jars to be permanently numbered with metal labels wired to the jar, and each patron to have a number corresponding to the one on the jar. In the bottom of each of these jars put one-twentieth of an ounce of powdered corrossive sublimate, to which has been added one one-hundredth of its weight of acid magenta, or any other of the analin colors that would not be destroyed under the conditions present. In this way any milk which has the poisonous corrossive sublimate in it will have such a vivid pink color that there will be no danger of any one drinking it by mistake or of its being fed to animals."

Instead of using corrossive sublimate as a preservative, the milk may be allowed to sour, and then be shaken up with a little powdered lye, as suggested by Mr. E. H. Farrington of the Illinois Station. This treatment brings the curdeled milk back to such a condition that it can be easily analyzed.

"Any day in the week a correct sample of the milk measuring one-fourth of a pint, taken either by a sampling tube or a dipper, is put into this jar. Any other day in the week a second sample of the same size, and taken in the same way, should be added. A third sample, taken on any other day, may also be added if great accuracy is desired. The patron should not know beforehand what day these samples are to be taken, and they need not be taken the same day for all the patrons. The cans can be prepared Saturday morning and samples taken any day during the week, so that the patron can never be sure when he brings his milk whether or not a sample is to be taken from that day's milk. At the end of the week the mixed sample is analyzed and its analysis considered to represent the average character of the milk delivered during the week."

Very accurate average samples are obtained if proper care is used in sampling.

MAKING THE TEST.

Sampling the Milk. It is absolutely necessary to have the sample represent as nearly as possible the whole lot of milk from which it is taken, and it is a much more difficult matter than many suppose.

The most reliable method of sampling is by the use of a *sampling tube which takes out a core of milk from the top to the bottom. This sampling tube can be made by any ordinary tinsmith by taking a piece of brass tubing an inch in diameter, running a wire through the length of it, terminating at the upper part in a bend for handle, the other end of the wire being soldered into a firm sheet of iron which is covered on its upper surface by a piece of rubber packing. This iron valve should be a trifle larger than the size of the tubing. The wire is held in the center of the tube by a small wire loop at the top and bottom, near the ends of the tube. By pushing down on the handle the valve is carried away from the bottom of the tube, leaving a place for the milk to enter. While in this position the tube is pushed down vertically into the milk in the weighing can until it reaches the bottom. The wire is then pulled up, closing the bottom of the tube, taking with it a core of milk from the top to the bottom of the can The bottom of the tube is put into the can or jar in which the sample is to be kept, and by loosening the valve the milk is allowed to flow out. Three such samples will furnish enough milk for a sample for analysis, and will give a sample that is a correct average of all the milk. But even when using this it is advisable to stir the milk well with a dipper before taking the sample. Of course if the amount of milk is small, one hundred to two hundred pounds, and it is stirred very thoroughly with a large dipper, it can be mixed so thoroughly that a correct sample may be taken out with a dipper.

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* **Bulletin 21, Vermont Experiment Station**

It is impracticable to sample a large amount of sour milk, but a small sample of a pint to a quart may be thoroughly mixed by adding five per cent. of strong ammonia water, which will dissolve the curd and permit a uniform mixture being made. When ammonia is added the final results should be increased by five per cent. Samples from sour milk are, however, never as satisfactory as those taken when the milk is in a proper condition.

" *Measuring the Milk.* When the milk has been sufficiently mixed, the milk pipette is filled by placing its lower end in the milk and sucking at the upper end until the milk rises above the mark on the stem; then remove the pipette from the mouth and quickly close the tube at the upper end by firmly pressing the end of the index finger upon it to prevent access of air. So long as this is done the milk cannot flow from the pipette. Holding the pipette in a perpendicular position, with the mark on a level with the eye carefully relieve the pressure on the finger so as to admit air slowly to the space above the milk. When the upper surface of the milk coincides with the mark upon the stem, the pressure should be renewed to stop the flow of milk. Next place the point of the pipette in the mouth of one of the test bottles, held in a slightly inclined position so that the milk will flow down the side of the tube, leaving a space for the air to escape without clogging the neck, and remove the finger, allowing the milk to flow into the bottle. After waiting a short time for the pipette to drain, blow into the upper end to expel the milk held by capillary attraction in the point. If the pipette is not dry when used it should be filled with the milk to be tested, and this thrown away before taking the test sample. If several samples of the same milk are taken for comparison, the milk should be poured once from one vessel to another after each sample is measured Neglect of this precaution may make a perceptible difference in the results, through the separation of cream, especially when the milk examined is rich.

Persons who have had no experience in the use of a pipette will do well to practice a short time by measuring water into a test bottle before attempting to make an analysis. The manipulation is easily acquired, and with a little practice milk may be measured nearly as rapidly with a pipette as with a graduate, and with much greater accuracy.

Adding the Acid. When the milk has been measured into the test bottles the necessary amount of sulphuric acid may be added immediately, or the bottles may be left for a day or two without materially changing the results. Samples that have remained in the test bottles more than a week have given the same amount of fat as samples tested immediately after being measured. If the milk has become coagulated the curd should be broken up by shaking the test bottle before the acid is added.

The volume of commercial sulphuric acid required for a test is approximately the same as that of the milk, 17.5 c. c. for the ordinary test. If too little acid is added, the casein is not all held in solution throughout the test, and an imperfect separation of the fat results. If too much acid is used the fat itself is attacked.

When all of the samples of milk to be tested are measured ready for the test, the acid measure is filled to the 17.5 c. c. mark with sulphuric acid, and from this it is carefully poured into a test bottle containing milk that is held in a slightly inclined position, for reasons given in directions for measuring milk. The acid, being much heavier than milk, sinks directly to the bottom of the test bottle without mixing with the milk that floats upon it. The acid and milk should be thoroughly mixed together by gently shaking with a rotary motion. At first there is a precipitation of curd from the milk, but this rapidly dissolves. There is a large amount of heat evolved by the chemical action, and the solution, at first nearly colorless, soon changes to a very dark brown, owing to the charring of the milk sugar and perhaps some other constituents of the milk.

Whirling the Bottles. The test bottles containing the mixture of milk and acid may be placed in the machine directly after the acid is added, or they may stand several hours without harm. An even number of bottles should be whirled at the same time, and they should be placed in the wheel in pairs opposite to each other, so that the equilibrium of the apparatus will not be disturbed. When all of the test bottles are placed in the apparatus, the cover is put on and the machine is turned, either by hand or by power, at such a rate that the wheel carrying the bottles will make from 600 to 800 revolutions per minute, and this motion must be kept up for six or seven minutes. If this wheel is less than about twenty inches in diameter the speed should be greater, or else the whirling should be continued for a longer time.

When the bottles are placed in the machine directly after the acid is added, the separation may be affected without any extra heat, as that caused by the chemical action is sufficient to keep the fat liquid. If the bottles have stood after the acid is added until the contents are cooled below 100° F., the water in the tank should be warmed to about 200° F. before putting the bottles in the machine. The bottles should not be kept heated in the machine as high as the boiling point of water while the separation is being effected. The proper degree of heat may be obtained by lighting the burner or kerosine stove under the jacket when the machine is started; so much water having been poured into the jacket as will be just heated to boiling when the whirling is finished. In this way hot water is always available for filling the tubes at the proper time. In creameries heat can be most easily supplied by steam connection with the boiler. If the machine is stopped after about six minutes, a layer of fat will be found upon the upper surface of the liquid in the tubes This fat will not usually be clear. This, however, will make no difference in the result, as the subsequent treatment will clarify it.

As soon as the bottles have been sufficiently whirled, they should be filled to the neck with hot water. This is most conveniently done by placing a vessel containing boiling water above the machine, and by means of a syphon, made from a small rubber tube with a glass tip, run the water directly into the bottles without removing them from the wheel. The flow of water can be perfectly controlled by a pinch-cock upon the rubber tube. The cover should then be replaced and the machine turned for one or two minutes, after which more hot water is added, filling the tube to about the seven per cent. mark. The fat will slowly rise into the graduated tube, losing its cloudy appearance as it passes through the hot water. When all of the bottles are filled, the cover is put upon the tank, and the machine again turned for a short time. During this time the water in the tank should be kept hot, either by placing a lamp or kerosine stove beneath it, or by pouring in a quantity of boiling hot water before starting the machine. If the fat in some of the tubes still has a cloudy appearance, the cover should be placed upon the tank and heat applied for a few minutes, when the fat should become clear and in condition to be measured. The clearing may be hastened by whirling the tubes while hot. When the bottles are allowed to cool off to a point where the fat will crystallize, and then warmed again, the fat will usually be much clearer than before, but as this does not materially change the volume of fat it is considered unnecessary. Even a slight cloudy appearance does no harm.

Measuring the Fat. The fat, when measured, should be warm enough to flow readily, so that the line between the acid liquid and the column of fat will quickly assume a horizontal position when the bottle is removed from the machine. Any temperature between 110° F. and and 150° F. will answer, but the higher temperature is to be preferred. The slight difference in the volume of fat due to this difference in temperature is not sufficient to materially affect results. A difference in temperature of 40° F. will make less than one-tenth per cent. difference in milk containing five per cent. of fat. To measure the fat, take a bottle from its socket and holding it in a perpendicular position read off the per cent. of fat on the scale. The reading can easily be taken to half divisions or to one-tenth per cent.

If the column of fat is less than about one division, as will sometimes happen with skimmilk, buttermilk or whey, it may assume a globular form instead of a uniform layer across the tube. When this occurs the fat can usually be estimated with sufficient accuracy by simple inspection, but if an accurate reading is desired it may be obtained by taking four samples of the milk in four test bottles, and after treating them in the usual way, until the bottles are ready to be filled with water, adding water to three of them only, filling them as full as possible without running them over. After whirling them for a minute to bring the fat all into the neck, the fat may be poured off from these three tubes into the fourth. If any fat remains adhering to the sides of these tubes they should be filled a second time with water and the remaining fat poured into the fourth bottle, which is then filled with water, whirled, and the reading taken. This divided by four will give the per cent. of fat.

FURTHER PRECAUTIONS.

The sulphuric acid used should be kept out of reach of all persons except those making the test, and great care should always be taken in handling it as it is very corrosive.

If the fat does not separate clear from the acid liquid when water is added to bring it into the neck, it indicates that the acid used is too weak, and more should be used. If the fat separates clear from the acid. but is blackened, it shows that the acid is too strong, and it should be diluted to a specific gravity of 1.82 before using, or a little less of the acid could be used for the test.

It sometimes happens in testing buttermilk, that is quite sour, that the addition of water to bring the fat into the neck of the bottle where it can be measured, causes a precipitate of casein, or other matter, which mingles with the fat and prevents an accurate reading. This difficulty has also occurred a few times with milk that has stood a considerable time before testing. It may be entirely avoided by filling the bottles with a hot mixture of equal parts of sulphuric acid and water, instead of water alone.

The greatest source of error is in the graduation of the tubes, and no one should purchase tubes except from reliable parties who will guarantee their accuracy.

In the Station laboratory tubes made by Emil Greiner, 146 William Street, New York City, are used These tubes are accurately graduated, are of the finest workmanship, and fully guaranteed by Mr. Greiner.

TIME REQUIRED FOR MAKING THE TEST.

On account of the large number of tests which may be carried along together, and the little attention which each demands, the average time required for a test is very small. Two samples of milk may be tested in duplicate in fifteen minutes, including all of the work from the mixing of samples to the cleaning of the bottles. After the milk has been measured, sixty tests may be made in less than two hours, including the cleaning of the bottles.

CLEANING THE TEST BOTTLES.

The bottles should be emptied while hot, and afterwards rinsed twice with hot water. They are then ready for another test. In emptying the bottles they should be inverted and given a circular motion, which causes the liquid to form a whirlpool and allows air to enter continuously in the center of the tube. In this way the bottles may be emptied and cleaned rapidly without leaving fat attached to their sides.

COST OF THE APPARATUS.

The complete tester can be obtained at the following prices :

10 bottle tester	$16 00
15 bottle tester	18 00
20 bottle tester	21 00
30 bottle tester	24 00
25 bottle tester, power	38 00
35 bottle tester, power	43 00
50 bottle tester, power	50 00

This includes test bottles and acid for sixty tests. The expense of operating depends upon the cost of commercial sulphuric acid. The wholesale price is, at present, about two cents per pound, and can be obtained at this price by the carboy, about 180 pounds. Freight rates are such that acid costs, laid down in Reno, fourteen cents per pound. One pound will make fourteen tests so the expense is about *one cent* per test.

ACCURACY OF THE BABCOCK TEST.

Little need be said on this point, for the fact that the method has been worked thousands of times and carefully and critically tested by hundreds of chemists and creamerymen, with the best of results, is a sufficient guarantee. However, the following figures, from work done in the Station laboratory, serve to strengthen the support that the method has already received by the many comparative tests which have been made and published

SAMPLE.	Gravimetric Method. Per ct. fat.	Babcock Test. Per ct. fat.	Difference.
Herd milk	5.05	5.00	- .05
Individual cow	3.47	3.49	+ .07
Herd milk	4.50	4.40	+ .01
Individual cow	4.30	4.40	— .10
Individual cow	4.60	4.60	.00
Individual cow	5.09	5.00	+ .09
Individual cow	4.36	4.40	— .04
Buttermilk	8.06	8.00	+ .06
Herd milk	4.20	4.15	+ .05
Herd milk	4.02	4.10	— .08
Herd milk	3.63	3.70	— .07
Skimmed milk	0.15	0.10	+ .05
Herd milk	4.20	4.10	+ .10
Herd milk	4.58	4.60	— .02
Herd milk	3.76	3.70	+ .06
Herd milk	3.64	3.60	+ .04
Herd milk	3.57	3.90	— .03
Buttermilk	0.25	0.20	+ .05
Individual cow	4.88	4.85	+ .03
Individual cow	4.60	4.50	+ .10
Herd milk	3.47	3.40	+ .07
Individual cow	3.80	3.80	.00
Individual cow	4.58	4.60	— .02
Individual cow	3.95	3.90	- .05
Herd milk	4.40	4.40	.00

PAYING FOR MILK.

There are two methods by which milk can be paid for according to its content of butter fat. The first is on a basis of milk delivered without regard to the quantity of butter made from it; the second is based upon the amount of butter made.

"Suppose, for instance, a creamery agrees to pay 80 cents per cwt. for milk containing 4 per cent. of butter fat, which means four pounds of fat in each hundred pounds of milk. This would be twenty cents for each pound of fat. Then a milk that contained 5 per cent. would be paid for at the rate of a dollar a hundred pounds, while only 70 cents a hundred would be paid for 3½ per cent. milk. The other method, paying according to the butter produced, is more complicated. It is done as follows: Multiply the per cent. of fat in each man's milk or cream by the number of hundred pounds he has delivered; this gives the pounds of fat in the milk. The sum of the butter fat furnished by the several patrons gives the whole amount that went in to make up the butter. The number of pounds of butter divided by the number of pounds of fat, gives the pounds of butter made from each pound of fat. This result multiplied by the pounds of fat furnished by a given patron gives the pounds of butter to be credited to the milk or cream delivered by that patron.

An example will make this clear.

A brings 645 pounds milk containing 4.20 per cent fat.
B " 389 " " " 4.75 " " "
C " 200 " cream " 17.50 " " "

All the rest together bring 8,000 pounds of milk containing 4 per cent. fat.

A is credited with 6.45 by 4.20 = 26.09 pounds fat.
B " " " 3.89 by 4.75 = 18.48 " "
C " " " 2.00 by 17.50 = 35.00 " "
The rest are " 80.00 by 4.00 = 320.00 " "

The day's receipts are, 399.57 " "

The butter maker finds he has made 420 pounds of butter ready for market.

420 divided by 399.57 = 1.05.

Each pound of fat has therefore made 1.05 pounds of butter.

A is credited with 26.09 by 1.05 = 27.39 pounds butter.
B " " " 18.49 by 1.05 = 19.41 " "
C " " " 35.50 by 1.05 = 36.85 " "
The rest are " 320.00 by 1.05 = 336.00 " "

419.65

**Table for Facilitating Calculations when paying for milk on the basis of its fat contents.*

Per ct. fat.	PRICE OF MILK PER HUNDRED POUNDS.									
3.00	1.00	.97	94	.91	.88	.86	.83	.81	.79	.77
3.10	1.03	1.00	.97	.94	.91	.89	.86	.84	.82	.79
3.20	1.07	1.03	1.00	.97	.94	.91	.89	.86	.85	.82
3.30	1.10	1.07	1.03	1.00	.97	.94	.92	.89	.87	.84
3.40	1.13	1.10	1.06	1.03	1.00	.97	.94	.92	.90	.87
3.50	1.17	1.13	1.09	1.06	1.03	1.00	.97	95	.93	.89
3.60	1.20	1.16	1.12	1.09	1.06	1.03	1.00	.97	.95	.92
3.70	1.23	1.19	1.16	1.12	1.09	1.06	1.03	1.00	.98	.94
3.80	1.27	1.23	1.19	1.15	1.12	1.09	1.06	1.03	1.00	.97
3.90	1.30	1.26	1.22	1.18	1.15	1.11	1.08	1.06	1.03	1.00
4.00	1.33	1.29	1.25	1.21	1.18	1.14	1.11	1.08	1.06	1.02
4.10	1.37	1.32	1.28	1.24	1.21	1.17	1.14	1.11	1.08	1.05
4.20	1.40	1.35	1.31	1.27	1.24	1.20	1.17	1.14	1.11	1.07
4.30	1.43	1.39	1.34	1.30	1.26	1.23	1.19	1.17	1.14	1.10
4.40	1.47	1.42	1.38	1.33	1.29	1.26	1.22	1.19	1.16	1.12
4.50	1.50	1.45	1.41	1.36	1.32	1.29	1.25	1.22	1.19	1.15
4.60	1.53	1.48	1.44	1.39	1.35	1.31	1.28	1.25	1.21	1.17
4.70	1.57	1.52	1.47	1.42	1.38	1.34	1.31	1.28	1.24	1.20
4.80	1.60	1.55	1.50	1.45	1.41	1.37	1.33	1.30	1.27	1.23
4.90	1.63	1.58	1.53	1.48	1.44	1.40	1.36	1.33	1.29	1.25
5.00	1.67	1.61	1.56	1.52	1.47	1.43	1.39	1.36	1.32	1.28
5.10	1.70	1.65	1.59	1.55	1.50	1.46	1.42	1.39	1.35	1.30
5.20	1.73	1.68	1.63	1.58	1.53	1.49	1.44	1.41	1.37	1.33
5.30	1.77	1.71	1.66	1.61	1.56	1.51	1.47	1.44	1.40	1.35
5.40	1.80	1.74	1.69	1.64	1.59	1.54	1.50	1.47	1.42	1.38
5.50	1.83	1.77	1.72	1.67	1.62	1.57	1.53	1.50	1.45	1.41
5.60	1.87	1.81	1.75	1.70	1.65	1.60	1.56	1.52	1.48	1.44
5.70	1.90	1.84	1.78	1.73	1.68	1.63	1.58	1.55	1.50	1.46
5.80	1.93	1.87	1.81	1.76	1.71	1.66	1.61	1.57	1.53	1.49
5.90	1.97	1.90	1.84	1.79	1.74	1.69	1.64	1.60	1.56	1.51
6.00	2.00	1.94	1.88	1.82	1.76	1.71	1.67	1.62	1.58	1.54

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*From Bulletin 16, Vermont Experiment Station.

Per ct. fat.	PRICE OF MILK PER HUNDRED POUNDS									
3.00	.75	.73	.71	.70	.68	.67	.65	.64	63	61
3.10	.78	.75	.73	.72	.70	.69	.67	66	.65	.63
3.20	.80	.78	.76	.75	.73	.71	.69	.68	.67	.65
3.30	.83	.80	.78	.77	.75	.74	.72	.70	.69	.67
3.40	.85	.83	.81	.79	.77	.76	.74	.73	.71	.69
3.50	.88	.85	.83	.82	.79	.78	.76	.75	.73	.71
3.60	.90	.88	.85	.84	.82	.80	.78	.77	.75	.73
3.70	.93	.90	88	.86	.84	.83	.80	.79	.77	.75
3.80	.95	.93	.90	.89	.86	.85	.82	.81	.80	.77
3.90	.98	.95	.92	.91	.88	87	.85	.83	.82	.79
4.00	1.00	.97	.95	.93	.91	.89	.87	.85	.84	.81
4.10	1.03	1.00	.97	.96	.93	91	.89	87	.86	.83
4.20	1.05	1.02	1.00	.98	.95	94	91	.90	.88	.85
4.30	1.08	1.05	1.02	1.00	.98	.96	.93	.92	.90	.88
4.40	1.10	1.07	1.05	1.02	1.00	.98	.95	.94	.92	.90
4.50	1.13	1.10	1.07	1.05	1.02	1.00	.97	.96	94	.92
4.60	1.15	1.12	1.10	1.07	1.05	1.02	1.00	.98	.96	.94
4.70	1.18	1.15	1.12	1.09	1.07	1.04	1.02	1.00	98.	.96
4.80	1.20	1.17	1.14	1.12	1.09	1.07	1.04	1.02	1.00	98
4.90	1.23	1.20	1.17	1.14	1.11	1.09	1.07	1.04	1.02	1.00
5.00	1.25	1.22	1.19	1.16	1.14	1.11	1.09	1.06	1.04	1.02
5.10	1.28	1.24	1.21	1.19	1.16	1.13	1.11	1.09	1.06	1.04
5.20	1.30	1.27	1.24	1.21	1.18	1.16	1.13	1.11	1.08	1.06
5.30	1.33	1.29	1.26	1.23	1.20	1.18	1.15	1.13	1.10	1.08
5.40	1.35	1.32	1.29	1.26	1.23	1.20	1.17	1.15	1.12	1.10
5.50	1.38	1.34	1.31	1.28	1.25	1.22	1.20	1.17	1.14	1.12
5.60	1.40	1.37	1.34	1.30	1.27	1.24	1.22	1.19	1.17	1.14
5.70	1.43	1.39	1.36	1.33	1.30	1.27	1.24	1.21	1.19	1.16
5.80	1.45	1.41	1.39	1.35	1.32	1.29	1.26	1.23	1.21	1.18
5.90	1.48	1.44	1.41	1.38	1.34	1.31	1.28	1.26	1.23	1.20
6.00	1.50	1.46	1.43	1.40	1.36	1.33	1.30	1.28	1.25	1.22

Per ct. fat.	PRICE OF MILK PER HUNDRED POUNDS.										
3.00	.60	.59	.58	.57	.56	.55	.54	.53	.52	.51	.50
3 10	.62	.61	.60	.59	.58	.57	.56	.55	.54	.53	.52
3.20	.64	.63	.62	.61	.60	.59	.58	.57	.55	.54	53
3 30	.66	65	.64	63	.62	.60	.59	.58	.57	.56	.55
3.40	.68	.67	.66	.65	.63	.62	.61	.60	.59	.58	.57
3.50	.70	.69	.68	.66	.65	.64	.63	.62	.61	.59	.58
3.60	.72	.71	.70	.68	.67	.66	.65	.64	.62	.61	.60
3.70	.74	73	.71	.70	.69	.68	.67	.65	.64	.63	.62
3.80	.76	.75	.73	.72	.71	.70	.68	.67	.66	.65	.63
3.90	.78	.77	.75	.74	.73	.71	.70	.69	67	.66	.65
4.00	.80	.79	.77	.76	.75	73	.72	.71	.69	.68	.67
4.10	.82	.81	.79	.78	.76	75	.74	.72	.71	.70	.68
4.20	.84	83	.81	.80	.78	.77	.75	.74	.73	.71	.70
4.30	.86	.84	.83	82	.80	.79	.77	.76	.74	.73	.72
4.40	.88	.86	.85	83	.82	.80	.79	.78	.76	.75	.73
4.50	.90	.88	.87	85	.84	.82	.81	.79	.79	.76	.75
4 60	.92	.90	.89	.87	.86	.84	.83	.81	.80	.78	.77
4.70	.94	.92	.91	.89	.88	.86	.84	.83	.81	.80	.78
4.80	.96	.94	.93	.91	.90	.88	.86	.85	.83	.81	.80
4.90	.98	.96	.94	.93	.91	.90	.88	.86	.85	.83	.82
5 00	1.00	.98	.96	95	.93	.91	.90	.88	.87	.85	.83
5.10	1.02	1.00	.98	.96	.95	.93	.92	.90	.88	.86	.85
5 20	1.04	1 02	1.00	.98	.97	.95	.93	.92	.90	.88	.87
5.30	1.06	1.04	1.02	1.00	.99	.97	.95	.93	.92	.90	.88
5.40	1.08	1.06	1.04	1.02	1.00	.99	.97	.95	.93	.92	.90
5 50	1.10	1.08	1.06	1.04	1.02	1.00	.99	.97	.95	.93	.92
5.60	1 12	1.10	1.08	1.06	1.04	1.02	1.00	.98	.97	95	.93
5.70	1.14	1.12	1.10	1 08	1.06	1.04	1.02	1.00	.98	.97	.95
5.80	1.16	1.14	1.12	1.09	1.07	1.05	1.04	1.02	1.00	.98	.97
5 90	1.18	1.16	1.13	1.11	1.09	1.07	1.05	1.04	1.02	1.00	.98
6 00	1.20	1.18	1.15	1.13	1.11	1 09	1.07	1.05	1.03	1.02	1.00

INSTRUCTIONS FOR USING THE TABLE.

1. Decide how much is to be paid for each pound of butter fat. Multiply this by 4 and the result will be the amount to be paid for each hundred pounds of 4 per cent. milk. Select the next nearest number to this in the horizontal column opposite 4.00 and the perpendicular column passing through the selected number will be the column to be used as long as that price is employed. Multiply the number of hundred pounds of milk furnished by each man by the number in the selected perpendicular column that is opposite the per cent. of fat found in his milk, and the result will be the amount due him for his milk.

Example. It is decided to pay 18 cents per pound for butter fat. .18 by 4 = .72. Then the man who furnishes 4 per cent. milk is to get .72 per hundred for it. Start at 4.00 on the left side of the table and move to the right until you reach .72 It will be found in a columm beginning with .54 and ending with 1.07, which means that at the price of 18 cents per pound for butter fat, .54 per hundred is paid for 3.00 per cent. milk, etc.

A brings 645 pounds of milk containing 4.20 per cent. fat. The number opposite 4.20 in the selected column is .75. 6.45 by 75 = $4.84 due A for his milk.

E brings 600 pounds 3.65 per cent. milk. 3.65 is half way between 3.60 and 3.70 and hence the price is half way between .65 and .67, or .66.

6.00 by .66 = $3.96 due E.

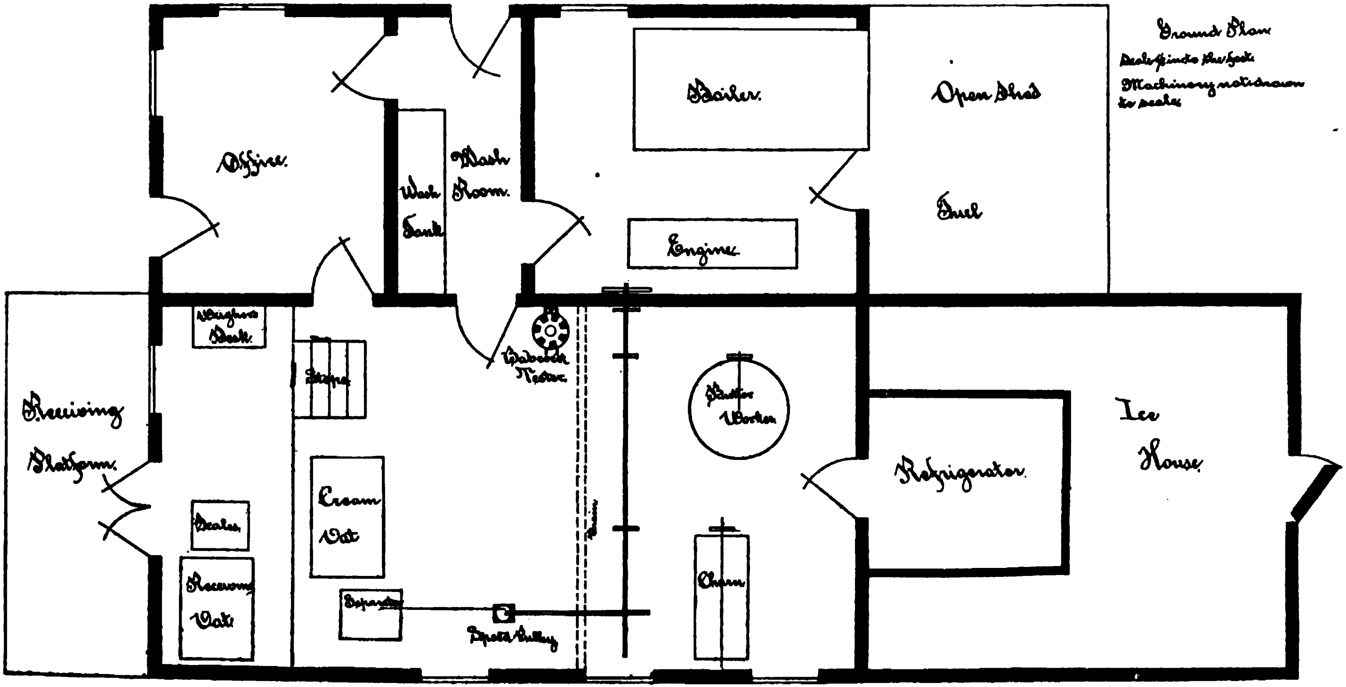
F brings 425 pounds 5.93 per cent. milk. 5.93 is nearer 5.90 than 6.00 ∴ 4.25 by 1.04 = $4.42 due F.

2. It is intended to pay the patrons whatever is received for the butter less a certain amount per pound for cost of making and marketing. Multiply each man's milk by the per cent. of fat it contains and the sum of the several products will be the total amount of fat contained in the day's milk. Divide the pounds of butter made from the milk by the pounds of fat it contained to find how much butter each pound of fat makes. Multiplying the amount to be paid for each pound of butter by this last result will give the amount to be paid for each pound of fat. Suppose the patrons furnish milk containing 400 pounds butter fat which makes 420 pounds butter, selling for 27 cents per pound, and 4 cents is to be deducted for expenses.

27 — 4 = 23c. 420 divided by 400 = 1.05.

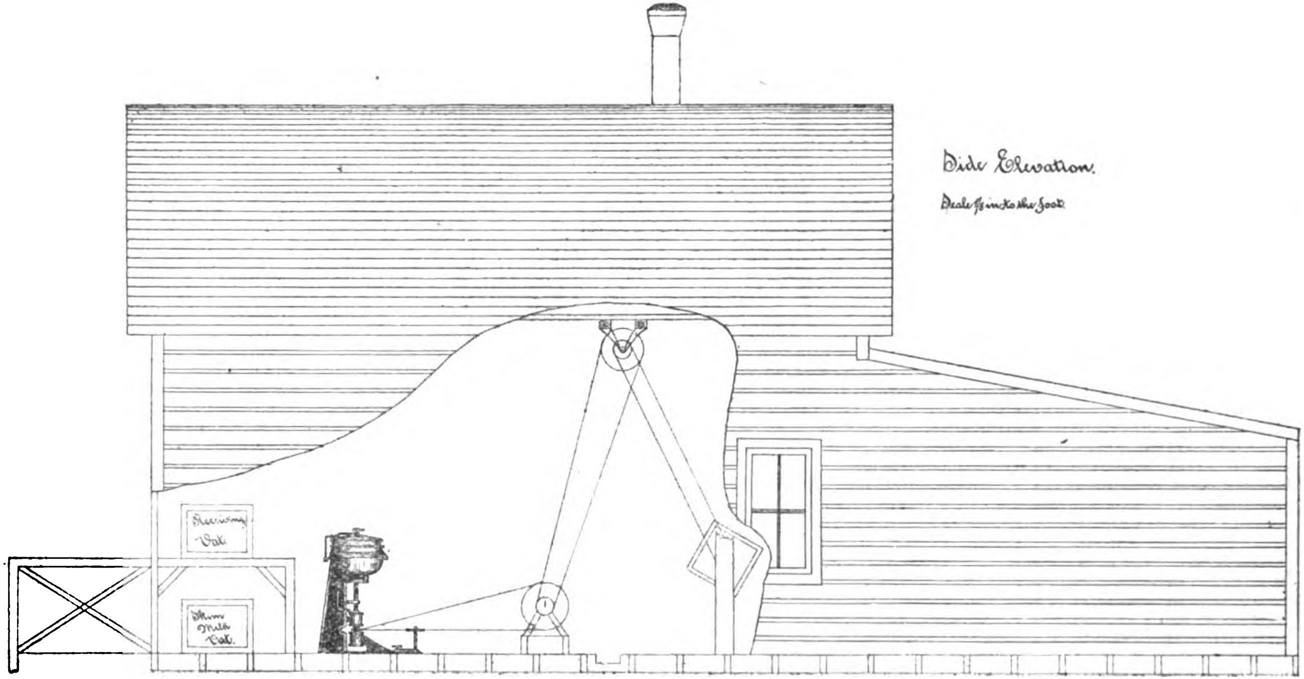
23 by 1 05 = 24.15c. to be paid for each pound fat. 24.15 by 4 = 97c. to be paid per hundred for 4 per cent milk. Starting on the table at 4.00 and going to the right .97 is found in the column headed .73, which would then be used as before.

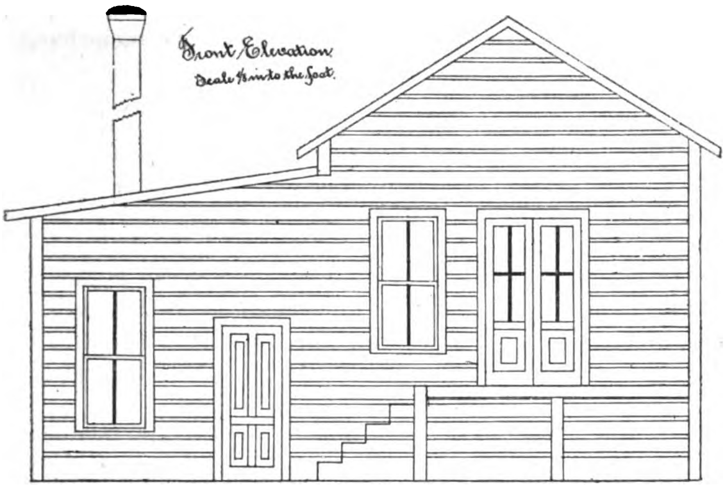
THE MODERN CREAMERY.



Side Elevation.

Scale 3/8 in. to the foot.





SPECIFICATIONS.

FOUNDATION.

Main building and annex to have stone foundation carried one foot, or more, below surface of ground, and to be not less than six inches above ground at any point.

Ice house foundation of stone carried two feet or more below surface of ground, and not less than six inches above ground at any point. Foundation walls shall not be less than 12 inches thick ; laid in good lime mortar (or if desired, cement).

Foundation bed for engine shall be not less than three feet below ground surface, and built up to level of engineroom floor, desired height above floor to be of brick ; anchor bolts for engine to be built in from bottom of foundation.

Foundation for separator to be not less than three feet below ground and built up level with top of floor joist in main building ; anchor bolts to be built in from bottom of foundation. All stone for engine bed and separator foundation to be laid in cement.

SILLS.

Sills of main building to be 6x6 inches, halved together at corners, lap splices where needed, and to be laid in good lime mortar on top of foundation.

Sills for annex, ice house and refrigerator to be 4x4 inches, laid in good lime mortar, upper surface on level with sills of main building.

JOIST.

Joist for main building to be 2x12 inches with 24-inch centers, cut to give floor fall of two inches from front of building to drain, and one inch from refrigerator door to drain, and to be level crosswise of building.

The joists forming two sides of the drain to be as free from knots as possible; inside and upper edge to be dressed, as also plank forming bottom of drain, top of said plank to be not less than one inch below floor at outer wall, and not less than two inches at engine room wall, there to connect with sewer under engine room floor

Joist for annex to be 2x12 inches with 24-inch centers, to run crosswise of building; inside end to rest on main building sills; all joist to have at least one set of bridging.

Joist for platform to be 2x6 inches with 24-inch centers.

STUDDING AND PLATES.

Studding for main building to consist of 2x6 inch with 24-inch centers, toenailed to sill and joist; two girt strips carried round the wall, one eight inches from the floor, the other dividing the distance between first and plates, and to be firmly toenailed to studding.

Plates to be 2x6 inches doubled, lapped at corners oints broken, well spiked together and to top of studs.

Studding for annex to be 2x4 inches, with 24-inch centers. Girt strips to be carried around same as in main building. Plates of 2x4 doubled, joints broken, and spiked as in main building.

Studding for ice house to be 2x4 inches, with 24-inch centers, toenailed to sills. No girts to ice house as they will interfere with filling the walls. Plates 2x4 inches, joints broken, and spiked as in main building.

Studding for refrigerator to be 2x4 inches with 24-inch centers; plates 2x4 inch single.

ROOF.

Ceiling joist 2x4 inches, to run from plate to plate, spiked to every pair of rafters and toenailed to plates, supported at center with 1x6 inch, nailed firmly to joist, rafters and collar beam.

Rafters to be 2x4 inches, cut to third pitch with 24 inch-centers.

Collar beams to be 1x6 inches, nailed firmly half way up each set of rafters.

Sheathing to be 1x8 inches laid to 10-inch centers.

Shingles to be of redwood, laid five inches to weather.

Office portion of annex ceiling joist 2x4 inches, to run level from plate to wall of main building, 24-inch centers over office and wash room, and then only on line of partitions as shown in plan.

Rafters 2x4 inches, cut as shown in plan, held to main building by ribbon strip carried along studs, sheathed and shingled as in main building.

Ice house rafters to be 2x6 inches, cut as shown in plan, held to main building with ribbon strip carried along studs, supported in center by girder of 4x4 inches with posts of 4x4 inches (redwood) at rear corners of refrigerator, and outer ends, sheathed and shingled as main building.

FINISH.

Building to be weatherboarded with 8-inch rustic, to have 12-inch baseboard, with water table above it to project not less than one and a half inches beyond rustic, a cornice to extend around the building with exception of ice house, consisting of freze, planchard and facia boards of suitable width ; corner boards to cover uneven ends of rustic, neatly jointed and cut in between freze and water table.

Office and work room walls and ceiling to be ceiled with 1x4 inch matched and dressed pine, ceiling to be placed vertically on frame and blind nailed firmly to each line of girts.

Refrigerator to be ceiled with 1x4 inch matched and dressed redwood. (In no case use pine in the refrigerator).

Floors of office and workroom to be 1¼x4 inches matched and dressed pine, blind nailed to every joist. Engineroom platforms and washroom floors to be of the same material and treated in a like manner.

Refrigerator floor should be leveled off, settled thoroughly and covered flush and smooth throughout with cement concrete (three parts of clean, coarse gravel and one part cement) from four to six inches deep, to be finished with a true and even surface with equal parts of clean sharp sand and cement.

DOORS.

Doors on receiving platform, as shown in plan, to be double sash, 4x7 feet by 1½ inches; to swing outward so as not to interfere with work on inside of receiving platform. Refrigerator door to be made of two thicknesses 1x4 inches matched and dressed redwood, running diagonally, and nailed to light frame made of 2x4 inches, space between to be filled with charcoal. Ice house door to be made double with 4-inch air space in center. All other doors to be 2 feet 8 inches by 6 feet 8 inches by 1¼-inch-pannel.

WINDOWS.

All windows to be 10x16 inches, 12-light sash; weighted or not at discretion ot owner.

Estimates on window frames are for mill work, which can be obtained much cheaper than the frames can be made by hand.

PAINTING.

The roof should be painted with two coats Prince's Metalic, or other good fire-proof paint.

All other exposed woodwork should have nails set. holes puttied, knots shellaced and painted with two coats of good paint, any suitable color.

Inside, throughout, should be oiled with boiled linsed oil and given two coats of shellac.

BILL OF LUMBER.

COMMON LUMBER.

		Total feet.
Sills for main building—8 pieces 6x16 inches by 16 feet		384
Sills for annex	2 pieces 4x4 inches by 12 feet	32
	8 pieces 4x4 inches by 16 feet	170⅔
Sills for ice house	2 pieces 4x4 inches by 18 feet	48
	1 piece 4x4 inches by 16 feet	21⅓
Sills for refrigerator	1 piece 4x4 inches by 16 feet	21⅓
	1 piece 4x4 inches by 10 feet	13⅓
Joist for main building—16 pieces 2x12 inches by 16 feet		512
Joist for annex—16 pieces 2x12 inches by 12 feet		384
Bridging—8 pieces 2x4 inches by 16 feet		85⅓
Bottom of drain—1 piece 2x10 inches by 18 feet		30
Stringers for platform—3 pieces 2x4 inches by 12 feet		24
Joist for platform—7 pieces 2x6 inches by 14 feet		98
Braces for platform—3 pieces 2x4 inches by 12 feet		24
Posts for platform—2 pieces 4x4 inches by 12 feet		32
Studs for main building—48 pieces 2x6 inches by 14 feet		672
Studs for annex—40 pieces 2x4 inches by 12 feet		320
Studs for ice house—28 pieces 2x4 inches by 12 feet		224

	Total feet.
Studs for refrigerator—7 pieces 2x4 inches by 20 feet..	93⅓
Plates for main building—12 pieces 2x6 inches by 16 feet	192
Plates for annex—4 pieces 2x4 inches by 16 feet	42⅔
Plates for ice house—2 pieces 2x4 inches by 16 feet	21⅓
Plates for refrigerator 2 pieces 2x4 inches by 16 feet..	21⅓
1 piece 2x4 inches by 14 feet.	9⅓
Ceiling joist for main building—14 pieces 2x4 inches by 16 feet.	149⅓
Ceiling joist for annex—8 pieces 2x4 inches by 12 feet.	64
Ceiling joist for refrigerator—3 pieces 2x4 inches by 16 feet	32
Corner posts and plates for open shed—3 pieces 4x4 inches by 12 feet	48
Brace supports for same—1 piece 2x4 inches by 12 feet..	8
Rafters for main building—32 pieces 2x4 inches by 12 feet.	256
Rafters for annex—16 pieces 2x4 inches by 14 feet	149⅓
Rafters for ice house—9 pieces 2x6 inches by 20 feet	180
Rafters for open shed—7 pieces 2x4 inches by 12 feet	56
Sheathing for main building and annex—1x8 inches by 16 feet.	720
Sheathing for ice house and open shed—1x8 inches by 16 feet.	300
Collar beams for main building—15 pieces 1x6 inches by 12 feet.	90
Ceiling joist supports—8 pieces 1x6 inches by 12 feet.	48
Hanger supports—2 pieces 4x6 inches by 16 feet (clear)	64

DRESSED LUMBER.

Rustic for whole building	2.200
(Cornice) freze and planchard 12 pieces 1x12 inches by 12 feet.	144
6 pieces 1x12 inches by 16 feet.	96
Facia, main building 3 pieces 1x16 inches by 16 feet. to cut	64
3 pieces 1x16 inches by 12 feet.	48
Corner boards—8 pieces 1x6 inches by 14 feet	56
Ridge boards—4 pieces 1x6 inches by 16 feet.	32
Facia for ice house—1 piece 1x16 inches by 18 feet to cut.	24
Shingles	16 000
Building paper	1,666
Flooring—1¼x4 inches	1.280
Platform floors—1x4 inches by 12 feet.	240
Ceiling for ice house—1x12 inches by 16 feet (common)	1 000
Matched and dressed ceiling—1x4 inches	3,450
For refrigerator (redwood)—1x4 inches	300
Windows—6 frames; 6 set sash 10x16 inches, 12-light.	
Doors (7) 2 feet 8 inches by 6 feet 8 inches by 1¼, panel	
One set double sash 4x7 feet by 1½ inches	
Five frames for same	
Platform steps—	
Risers—1 piece 2x12 inches by 16 feet.	32
Steps—1 piece 1¼x12 inches by 16 feet.	20
Outside steps—	
Risers—1 piece 2x12 inches by 16 feet	32
Steps—1 piece 1¼x12 inches by 16 feet	20
Wash tank 1 piece 2x12 inches by 20 feet (sides and ends).	40
1 piece 2x12 inches by 16 feet (bottom)	32
Bolts for same, 4, 28x½ inch	
Sewer under engine room floor—3 pieces 1x12 inches by 14 feet (redwood)	42
Churn supports—	
Standards (2)—4x6 inches by 14 feet	48
Sill and plate (1)—4x6 inches by 12 feet.	24
Braces (1)—2x6 inches by 12 feet	12

ESTIMATED COST OF MATERIAL.

Lumber, common, 6,610 feet @ $17 per M	$112 37
Lumber, dressed, 8,228 feet @ $30 per M	246 84
Shingles, 16.000 @ $3 per M	48 00
Building paper, 1.660 square feet @ $5.60 per M	9 30
Window frames, 6, @ $4	24 00
Door frames. 7, at $3.50	24 50
Double sash door frame, 1, @ $4.50	4 50
Window sash, 6 set, @ $2 75	16 50
Doors, 7, @ $2.50	17 50
Double sash doors, 1 set, @ $6	6 00
Cement, 2 barrels, @ $7	14 00
Lime, 400 pounds, @ 1 cent	4 00
8 rim knob locks. @ 75 cents	6 00
1 rim knob lock @ $1	1 00
1 hasp and staple @ 25 cents	25
9 pair loose pin butts @ 15 cents	1 35
2 pair strap hinges @ 25 cents	50
60 pounds 10d nails, common, @ 5 cents	3 00
20 pounds 30d nails, common, @ 5 cents	1 00
150 pounds 8d nails, common, @ 5 cents	7 50
10 pounds 10d nails, finishing, @ 5 cents	50
5 pounds 6d nails, finishing, @ 5 cents	25
65 pounds 4d nails, shingle, @ 5 cents	3 25

CREAMERY OUTFIT.

1 6-H P. N. Y engine 1 8-H. P. horizontal boiler	450 00
1 separator, capacity 2,000 pounds per hour	500 00
1 300-gallon receiving vat	45 00
1 400-gallon Boyd's automatic cream vat	75 00
1 separator tempering vat	15 00
1 300-gallon box factory churn, oak	40 00
1 circular power butter worker	50 00
1 16-foot skim milk tank	18 00
1 platform scale, 600 pounds	35 00
1 salting scale, (½ ounce to 240 pounds)	8 00
1 60-gallon weight can	11 00
1 conductor head and 14 feet pipe	5 30
1 15-bottle Babcock tester	18 00
Pails, dippers, ladles, thermometers, etc.	4 00
1 butter packer	75
25 10-gallon shipping cans	75 00
Mops, brooms and scrubbing brushes	3 00
18 feet cold-rolled shafting, 1 7-16	12 50
3 12-inch drop hangers (adjustable) @ $3.90	11 70
1 pulley 15½x6 inches on line shaft to connect engine	4 60
I pulley 4x3 inches on line shaft to connect butter worker with counter shaft	2 00
1 pulley 4x3 inches on line shaft to connect cream vat with counter shaft	2 00
1 pulley 4½x6½ inches on line shaft to connect churn	2 50
1 pulley 22x4 inches on line shaft to connect separator intermediate	4 95
1 pulley 15x3 inches } on butter worker counter shaft	3 10
1 pulley 12x6½ inches	3 60

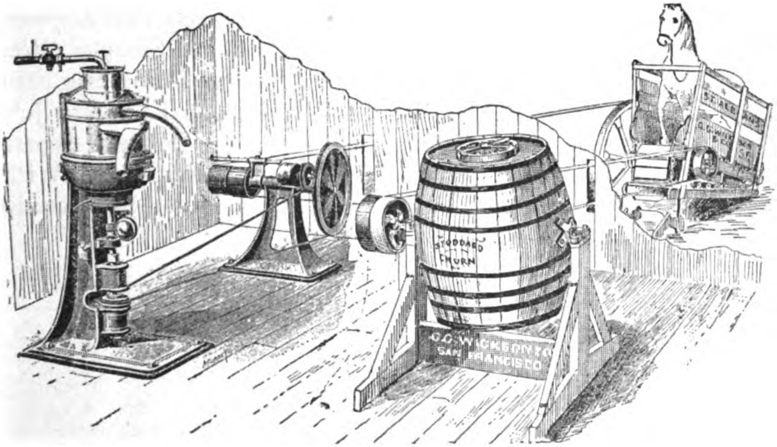
1 pulley 4x3 inches } on cream vat counter shaft	2 00
1 pulley 14x3 inches } on cream vat counter shaft	3 00
4 8-inch hangers @ $3.25	13 00
2 pieces 1 7-16 inches by 3 feet each, cold rolled shafting, and 4 collars	7 20
2 collars for line shaft	1 50
75 feet 3-inch belting	22 50
20 feet 5-inch belting	11 00
16 feet smokestack pipe	11 80
Pipe fittings and globe valves	10 00
Total	$2,034 11

☞These estimates are exclusive of freight.

POWER.

All things considered, steam power is the most satisfactory for creamery work. In some sections, especially on farms, fuel is scarce and horses plenty. In such cases the machinery can be driven successfully by horse-power, as shown in figure 34. The form of horse-power which gives best satisfaction for this work is the tread-power.

If a sufficient water pressure can be obtained a water motor wlll be found to be a very steady and most economical driving power.



CONCLUSION.

In conclusion we would warn all parties who may contemplate purchasing creamery machinery against the so called "Creamery Boomers," whose methods are most unscrupulous. Not only will they try to palm off an inferior and antiquated style of machinery, thinking we Nevadans will not know the difference, but they will make contracts for the erection and fitting out of creamers apparently on the most plausible terms, secure notes from the farmers for shares of the stock, sell them to some neighboring bank and depart.

When the day of reckoning comes the farmer can step up and settle with the bank, and when the creamery is built—if it ever is—get his money if he can.

This is a clear game of swindling, and all should be on their guard·

Buy nothing of any but responsible firms, and then not until you have thoroughly investigated and found out just what will best serve your needs.

Beware of the agent who can not say too much against the goods of a rival firm. He has an axe to grind and it is to your interest that you do not turn the grindstone.

The Station will gladly, at all times, secure estimates and put any one in communication with responsible firms, and aid in any possible way parties who propose to embark in the creamery business.

ACKNOWLEDGMENT.

We are indebted to Messrs. Cornish, Curtis & Green, Fort Atkinson, Wisconsin ; D. H. Roe & Co., Chicago, Ill.; P. M. Sharples, West Chester, Pa., and his Pacific Coast agent, A. J. Van Drake, San Francisco ,Cal.; the Vermont Farm Machine Co., Bellows Falls, Vt.; John Boyd, Chicago, Ill.: R. D. Harris, New York ; the De Laval Separator Co., New York, through their Pacific Coast agents, G. G. Wickson & Co., San Francisco, Cal., for the electrotypes ot their respective goods shown in this Bulletin.

THE WOOLLY APHIS OF THE APPLE.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 17.

RENO, NEVADA, JULY, 1892.

Agricultural Experiment Station.

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This Station is prepared to analyze and test fertilizers, soils, muck and gypsum, which may be of agricultural value, cattle foods, water, milk and dairy products, seeds, with reference to their germinating power and purity; to identify grasses and weeds and study forage plants ; to investigate the diseases of fruit and fruit trees, grains and other useful plants ; to make reports on injurious insects and the most practical means of combatting them.

THIS WORK IS DONE GRATIS FOR RESIDENTS OF THE STATE.

The Bulletins and Reports will be sent free to any farmer or other person interested in agriculture within the State.

Address all communications to

Agricultural Experiment Station.
Reno, Washoe County, Nevada.

CHEESE AND ITS MANUFACTURE.

N. E. WILSON.

Dairying is no longer an experiment in this State. The industry is firmly established and is destined to become one of the leading occupations of our people.

Nevada butter is unsurpassed in quality, and there is no reason why we can not make an equally good cheese. Cheese making is a most important part of the dairying industry, and one which yields a good revenue, especially when made in connection with butter.

The favorable manner in which Bulletin No. 16—"The Creamery Industry"—was received has led to the publication of the following outline of cheese and its manufacture.

THE CHEMISTRY OF CHEESE MAKING.

The curd of milk is the material of which cheese is made. This consists principally of casein, a nitrogenous substance resembling greatly in composition the albumen of the egg, fibrin of flesh and blood, gluten of various grains as wheat and oats, and legumine of peas, beans and other leguminous or pod-bearing plants.

Like these substances casein is colorless, odorless, insoluble in water and alcohol, soluble in alkaline solutions, and coagulated or curdled in such solutions by the addition of acids which neutralize the alkalinity. It ferments very readily, emitting a most disagreeable odor, and breaks up with the formation of several acids and ammonia.

Milk contains quite a proportion of free soda, which, being alkaline, The growing distances—20 inches between rows and 6 inches between beets—would scarcely permit, in soil of medium grade, the growth of more than ordinary sized beets. It might give better results to follow Mr. Gird's rule for thinning—from 8 to 10 inches apart.

FIELD WORK.

The principal part of the field trials at the Station were conducted on plat No. 8, containing one-half acre. The plats are numbered from west to east—from one to nine. The general slope of the plats is from west to east, allowing the flow of water for irrigation without hindrance the entire length.

The soil, as previously described, is largely sand, with some gravel, and a small amount of clay.

SEEDS AND SEEDING.

Seed was received from U. S. Department of Agriculture: Vilmorin's Improved and Kleinwanzlebener. From Richard Gird, Chino, Cal., Florimond Desprez, Vilmorin's Amelioree, Simon Le grande, and Gebruder. From Henry T. Oxnard, Grand Island, Neb., Desprez. From Western Beet Sugar Co., Watsonville, Cala., Verbesserte Kleinwanzlebener and Betterave a Collet rouge—Vilmorin's. Seed was sent to farmers in every county in the State—a total of six hundred and thirty-five pounds.

A small area was drilled with three varities of seed on March 28 for a test of early seeding and also of seed that had been in the seed building one year. The March sowing, at least for the season of 1892, was not as promising in its early advancement or harvested results as seed sown in May.

Seed that was one year old gave a good stand in the hot beds and open ground.

Dates of seeding for best results will vary in different portions of a State, and to some extent in the same locality, with varying seasons. The plowing was done in February, ten to eleven inches deep, without subsoiling, and by liberal use of roller and harrow the ground was put in good condition for seeding.

Vilmorin, Kleinwanzlebener, and Improved Kleinwanzlebener were drilled May 10. Desprez—twelve rows 24 inches apart and twelve rows 20 inches apart—was drilled May 11. All other varities on May 18, with the exception of two rows—Collet and Verbesserte Kleinwanzlebener—for late planting, on July 9th. The latter were practically of no value, although in 1891 beets sown July 1st gave sixteen per cent sugar and over four tons per acre.

The seeding was done with a garden seed drill to the depth of one inch. The rows were twenty inches apart, with the exception of twelve rows of Desprez which were twenty-four inches, and one hundred and thirty-two feet in length. Seeding per acre was varied, on a small area, from ten to forty pounds per acre. The writer is inclined to think, as stated in 1891, that nine to ten pounds of good seed—rows twenty inches apart—will give good results. One of our best farmers says eight pounds per acre.

Pajaro Valley, California, in 1890, the seeding was from four to six pounds per acre for bottom lands, and from two and one-half to four for mesa or hill lands. Their drills sowed in rows from fifteen to twenty-four inches apart, the former for bottom land the latter for hill land. It will be noticed in Mr. Gird's article that his best success has been with fourteen pounds.· His experience has been with two thousand to five thousand acres of beets. In Europe from twenty to thirty pounds of seed are used. The important item in seeding is to use sufficient seed to insure a solid stand of plants, which permits thinning to definite and uniform spaces. On good land the size of the beet is very largely regulated by the distance between rows, and especially by the distance between beets in the row. The size of the beet has much to do with the sugar content.

Large, rough beets yield a low sugar percentage. Well formed beets, weighing from one and one-half to two and one-half pounds —as a rule—will carry a high sugar per cent.

There is a close relation between good seed, enough of it, a solid stand of plants, high sugar content, and profits to the grower. Suitable land, proper thinning, and thorough cultivation are also necessities.

The assistance rendered by farmers in sowing seed forwarded by the Station and reporting results of the seasons' operations is thoroughly appreciated. A large amount of correspondence has been received that aided the bulletin work, but it is not practical to publish in full.

With the sugar beet seed was sent a report blank and suggestions on cultivation, copies of which are given below:

NEVADA AGRICULTURAL EXPERIMENT STATION.

SUGAR BEET EXPERIMENTS, SEASON OF 1892.

SUGGESTIONS ON CULTIVATION.

Plant early. The date will vary in different portions of the State; we obtained good results last season, at the Station, from sowing May 18. Carefully measure and prepare land before sowing. Seed should be drilled in or hand sown to a depth of at least one inch and not deeper than one and a half inches. Rows should be from eighteen to twenty inches apart. Eighteen inches is preferable, but if not sufficient for horse cultivation the distance may be increased to twenty-four inches.

THINNING AND CULTIVATION.

As soon as the rows of beets are plainly visible start the cultivator, not only to keep down all weeds but to keep the surface of the soil open and porous. It is very important to secure and maintain a vigorous growth during the early period of plant life. When beets put forth the fourth leaf and the root has about the diameter of a wheat straw, the plants should be thinned out to one in a place and about six inches apart in the row (it is well to use a rule occasionally as a distance of six inches looks small out in the field.) Thinning to a single plant is indispensable, for if two or more plants are left together the result will be ill-shaped and imperfectly developed beets of no value for making sugar. A single beet in a place will secure a root of good conical form, without side roots of "fingers and toes," about thirteen inches long and weighing from one to two pounds. *This is the beet* *wanted.* If the beet rises above the ground, care should be taken to hill it up for the part that ripens above the ground is of no value for sugar manufacture.

When the leaves cover the ground and the crop has taken possession of the field, cultivation should stop, and the plants given time to ripen and develop saccharine matter. If cultivation is prolonged and vegetable growth is stimulated, the production of sugar is likely to be diminished.

SAMPLES FOR ANALYSIS.

All persons receiving seeds from the Station are expected to send samples to the Station for analysis according to the following directions:

Select an average inside row and gather every beet for a distance depending on the width between rows, as follows:

From rows 16 inches apart gather 75 feet.
" " 18 " " " 66⅔ "
" " 20 " " " 59 4-5 "
" " 22 " " " 54 3-5 "
" " 24 " " " 50

Count the beets grown in the length of row given above. Cut off the tops, free from all dirt, and weigh the beets gathered from this length. The number of beets harvested in this length multiplied by 435.6 will give the total number per acre. The weight of beets harvested in this length, multiplied by 435.6 will give the yield per acre in pounds. In case the whole crop grown on one-eighth of any known part of an acre can be weighed, the yield per acre can be stated without following the method given above.

Select, from the beets thus gathered, six beets of medium size, great care being used to secure representative beets, neither too large nor too small; cut off the tops, wrap them in paper separately, label distinctly with name and address of grower and variety of beet.

If there are several different samples from different varieties of seed, or different conditions of cultivation, enclose each separately carefully labeled. Pack in small box or sew up in a sack and ship to NEVADA AGRICULTURAL EXPERIMENT STATION.

Washoe County. Reno, Nevada.

NEVADA AGRICULTURAL EXPERIMENT STATION.

SUGAR BEET EXPERIMENTS, SEASON OF 1892.

REPORT BLANK.

(This blank is to be filled out and sent to the Station when samples are sent for analysis.)

1. Variety ....
2. Date of seeding ....
3. Do you use garden seed drill? ....
4. Distance of rows apart..
5. Depth of seeding..
6. Number of cultivations with a horse..
7. Number of times hoed..
8. Dates of irrigation..

....

9. Total number of times irrigated..
10. Kind of soil..

....

11. Date of harvesting..
12. What use will you make of the beets?..
13. With a factory near you, how many acres of beets can farmers raise to an advantage in your section?..
14. What does it cost you to raise an acre of beets?..
15. Have you previously raised sugar beets? If so to what extent?

....

16. How many tons did you raise per acre, weight or measurement?..
17. Amount of seed per acre..

[From our own and the experience of others, it would seem best to sow at the rate of nine or ten pounds per acre.]

18. Remarks ....

....

....

Name..
P. O..
County ....

DIRECTIONS FOR MAKING OUT REPORT BLANKS.

It is of the greatest importance that all these questions should be answered. If you are not certain of an answer, give an estimate and put a question mark (?) after it.

In giving the character of the soil, describe it as well as you can and state whether it is old or new ground. If old, give crops of the preceding years and state whether the ground has been fertilized.

Under the head of remarks, give any additional particulars that seem of interest and importance, and make any suggestions that your experience affords.

CULTIVATION.

For horse cultivation an Iron Age cultivator was used on June 9th, 20th and 30th, July 2d, and 29th, with sufficient hoeing to keep the ground free from weeds and sufficiently loose about the beets to allow free growth.

THINNING

Was commenced when the beets were at the four leaf stage, reduced to one plant in a place and as nearly as possible to six inches apart. This was done entirely by hand, using the ordinary hoe.

TEMPERATURE.

The following table, furnished by Mr. W. H. North of the University, gives temperature and moisture during the growing season:

	May.	June.	July.	Aug.	Sept.	Oct.
Highest Temperature	85	91	93	93	90	82
Lowest Temperature	25	28	38	41	35	21
Mean Temperature	58.3	62.1	71	72.8	62.8	47.8
Total Precipitation	0.20	1.27	Trace	0	0.07	0.27
Number of cloudy days	2	3	0	5	3	7
Number of days on which .01 or more rain fell	3	2	0	0	2	6

IRRIGATION.

A light furrow for conducting water was run in the center of the space between the rows.

Irrigation began on May 19th and was continued on the following dates, May 28, June 10, 25, July 6, 26, August 5, 12, 21 and 29. The irrigation for sugar beets for 1892, as with other crops, was quite largely done late in the afternoon and evening.

HARVESTING

Began on November 1st and was carried on as fast as could be done with ordinary implements. A plow was used for throwing the beets out and the topping was done with knives. As there was light freezing every night some extra labor was required for protecting the beets. The yield for the half acre was eleven thousand three hundred pounds or at the rate of eleven tons—six hundred pounds per acre.

PITTING.

Beets placed in ordinary pits in the winter of 1891 and 1892, kept for five months in excellent condition, being crisp and practically free from sprouts, with small loss from decay, when taken out in the spring.

ITEMS FROM FARMERS.

In reply to the question, How many acres of beets can be raised in your section, with an opportunity for sale at a factory? Three farmers answered 10,000 acres. One answered 4,000. Another 1,000 acres.

Twenty-five hundred acres of good, average beets are sufficient for a factory using about three hundred tons per day. Farmers have reported the cost of growing beets at from $35 to $40 per acre and in some instances a yield of 26 tons per acre. Several have reported the beet crop as practically destroyed by gophers.

The Wyoming Experiment Station, in Bulletin No. 12, speaks of the ground squirrels, or gophers, doing a large amount of damage. Some extracts are given with the hope that they will be of service to our farmers:

"The methods of destroying these pests are numerous. Many drown them out of their burrows and then kill them. This is a long and tedious method. I have seen water running from an irrigating ditch into one of the burrows for half a day, and it seemed as though another half day would have been insufficient to have filled the burrow. Then again, in this region, water is often difficult to obtain. It would in many instances have to be drawn in barrels or tanks for perhaps half a mile, or further.

"Many ranchmen and gardeners use strychnine, rough on rats, arsenic and other poisonous substances. Usually corn or some kind of grain is soaked in a solution of one of these poisons and is then placed near their burrows. This method has in some instances been satisfactory. There is this danger arising from the practice of such a method: Stock, poultry and the wild birds are as liable to get the grain as the squirrels.

"During the summer of 1892, a number of experiments, having in view the destruction of these squirrels, was carried on upon the Laramie Experiment Farm. For this purpose a quantity of *bi-sulphide of carbon* was used. This liquid is *highly inflamable and should NEVER be brought near fire, for fear of an explosion.* It is not poisonous or corrosive to the skin, and may be handled with impunity. Avoid breathing it; the vapor is unwholesome. The only danger is when brought in the presence of fire—a lighted pipe, a cigar or match would in all probability cause an explosion. Bi-sulphide of carbon should be kept from children and irresponsible persons, as they are liable to drink it, and the consequences might be serious. The unpleasant odor is easily and readily detected and by observing the proper precaution, no danger need be feared. The method of applying is to take a ball of cotton, about the size of an egg, and thoroughly saturate it with the bi-sulphide of carbon. One farmer, in Nebraska, in writing about the method of applying it, says that he uses the dried balls of horse manure and finds that they do equally well and are of less expense, and can be easily obtained. He finds that they readily absorb the bi-sulphide of carbon. With a rolling motion throw the cotton into the burrow and close the opening with some earth. The operation is simple and the result certain. The bi-sulphide of carbon evaporates rapidly, and being heavier than air, soon fills the burrow and smothers or overcomes the squirrels.

"The application should be made in the evening, at sun-down, as the squirrels are in their burrows at this time and the material will not be *wasted*. A pint of this liquid will be sufficient to treat twenty burrows.

"On the Laramie Experiment Farm ninety-six burrows were treated during the month of July. The applications were, with few exceptions, made in the evening. The next day the treated burrows were visited, and in no instance had the earth which had been used for plugging the opening been disturbed. A second and third visit to these burrows found them securely plugged. In two instances some animal, presumably a ground squirrel, had made an effort to dig open the burrow from the outside. The opening extended only to the ball of cotton, when, from all appearances, the task was given up. In forty-three instances "gophers" (squirrels) were driven or seen going into the burrows. These were treated at once, and fortunately none were opened. It is safe to conclude that none of them returned to the surface."

"EDITOR JOURNAL, COLUMBUS, NEB.—

"*Dear Sir:* It was my fortune in purchasing land here in Platt county to have a few prairie dogs thrown in, as a nuisance, and it has ever since been my wish to get rid of them. I tried various kinds of poison, shooting, drowning, etc, but all failed until quite recently I learned that bi-sulphide of carbon would destroy them. It is a liquid; can be purchased at the drug stores at a cost of from ten to fifteen cents a pound by the quantity. I bought from three different parties. The best and cheapest I got from Edward R. Taylor, of Cleveland, Ohio. It is sure death to prairie dogs, gophers, squirrels, etc. Mode of applying: Take a piece of cotton the size of a hen egg, saturate it with about one-half an ounce of the bi-sulphide of carbon, throw it into the hole of the animal, cover the top of the hole with ground, so that the cotton is loose in the hole. A gas is formed and the dogs are killed. I have destroyed my dogs on about eighty acres at a cost of $30, and increased the value of the land $500. One pound will do for twenty-five holes. This medicine is quickly applied and is sure death. No humbug about it.

"Very respectfully thy friend,
"ISAIAH LIGHTNER,
"Matson, Platte County, Neb."

Extracts are given below from a letter received from Mr. Thomas Whelan, of Pine Valley, who gives his experience for the season and also reasons why, in his opinion, a sugar factory would not pay in his section of the State.

In prospecting on an enterprise requiring the amount of capital necessary in a beet sugar plant it is desirable to hear from farmers who oppose as well as those who favor the undertaking.

Mr. Whelan says: "My ground, which is a rich loam, was seeded April 26. Shortly after they came up we had a severe frost which cut them down, and had several nights severe frost in the months of May and June and as a consequence we lost nearly all our vegetables, I am satisfied that the sugar beet cannot be raised in this section of the State at a profit for the manufacture of sugar, for the following reasons: 1. We are liable to have frost any night in the year. 2. Labor is too high. 3. Water is too scarce to raise them in quantities to justify a sugar plant. 4. Transportation is too high. 5. There is not sufficient home consumption to justify a one horse factory. One thousand barrels of sugar would supply the people of this section for a radius of one hundred and fifty miles for one year."

A newspaper item credits a Nebraska farmer with growing thirty-six tons of sugar beets on one acre of ground, at a cost of $40 and securing a prize of $100. The beets were worth at the factory $5 50 per ton. This example shows what can be done under favorable conditions, with the extra incentive of one hundred dollars.

IMPLEMENTS.

The cuts, of the improved implements for the cultivation of sugar beets, were kindly furnished by the Moline Plow Company, of Illinois. The subsoil plow, shown in Figure 1, is of especial value where the soil is too hard to allow the beets to penetrate to the depth of thirteen inches or more. The seeder, shown in Figure 2, is said to be easy to adjust for sowing different amounts of seed and is satisfactory in doing all parts of the field work. As it drills four rows at once, each ten hours in the field must be effective.

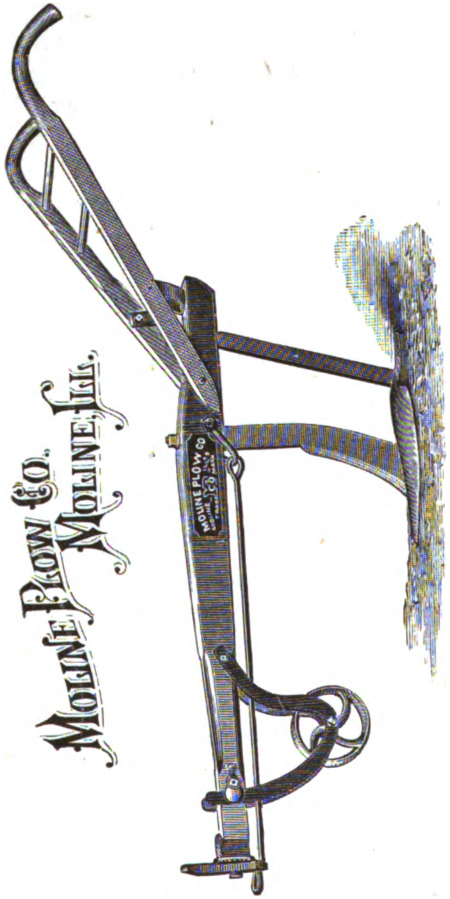
Moline Plow Co.
Moline, Ill.
MOLINE PLOW CO

Figure 1.

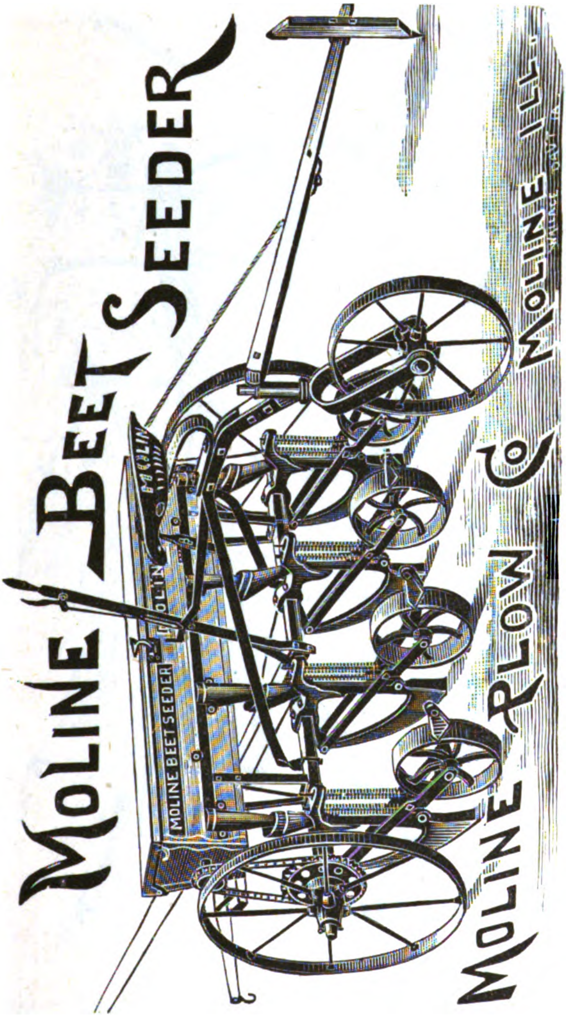
MOLINE BEET SEEDER
MOLINE BEET SEEDER
MOLIN
MOLINE PLOW Co
MOLINE ILL.

Figure 2

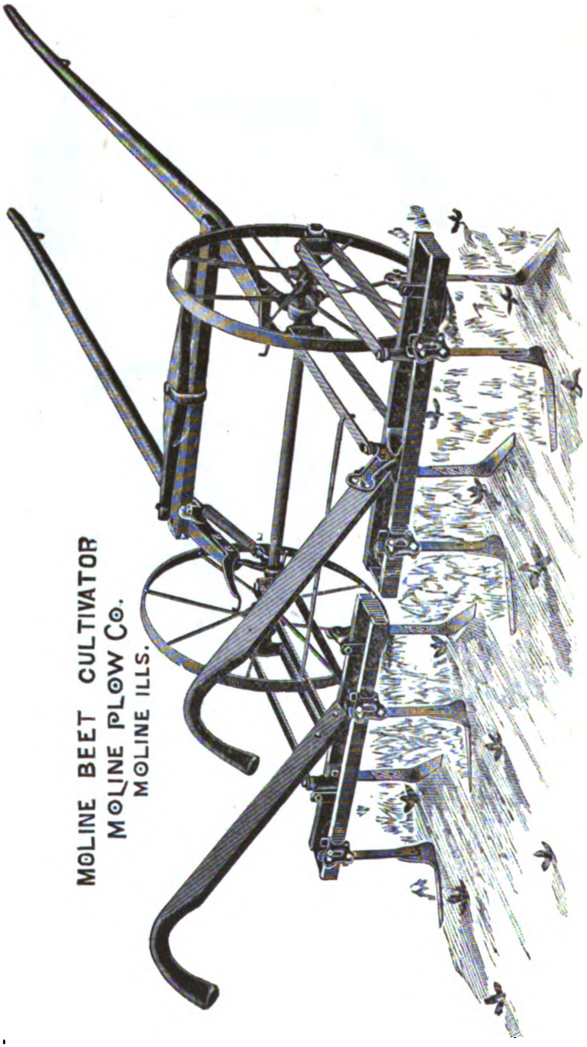
MOLINE BEET CULTIVATOR
MOLINE PLOW Co.
MOLINE ILLS.

Figure 3.

The horse hoe, or beet cultivator, represented in Figure 3, is valuable for ctltivating four rows at once, at any age of the beets. A certain amount of hand labor is necessary, especially in thinning to one plant (the latter is necessary under all circumstances) and in removing weeds that grow near to the beets.

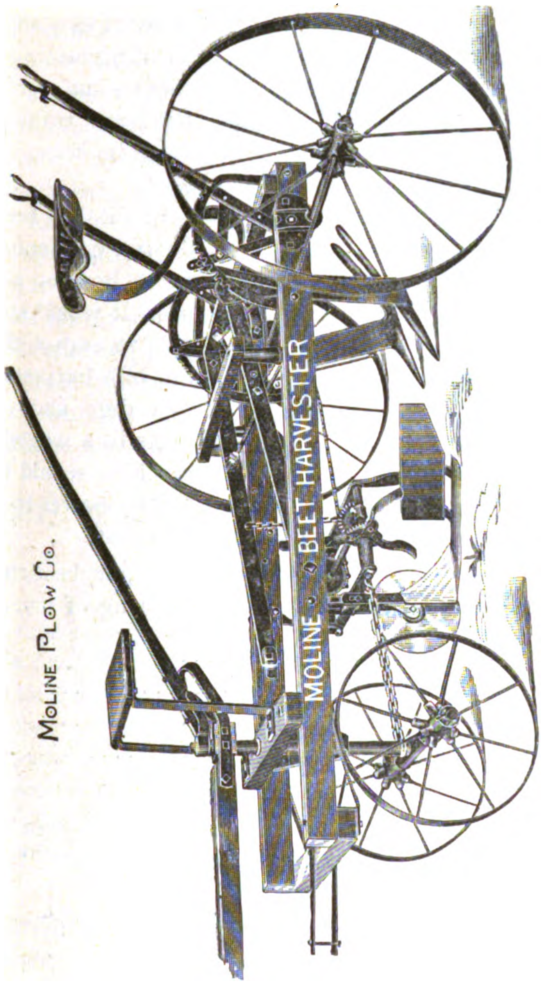

Figure 4.

Figure 4 gives an idea of a beet harvester, which, if improved to a point of doing successful work, will be one of the most important implements on the list. At last accounts it was not a complete success, although later improvements may have been made.

Figure 5 shows a typical sugar beet, which should be about thirteen inches in length, free from side roots of any size—to allow of easy and complete washing before going to the slicer—and of gradual taper. Different varities of beets vary in form, tosome extent.

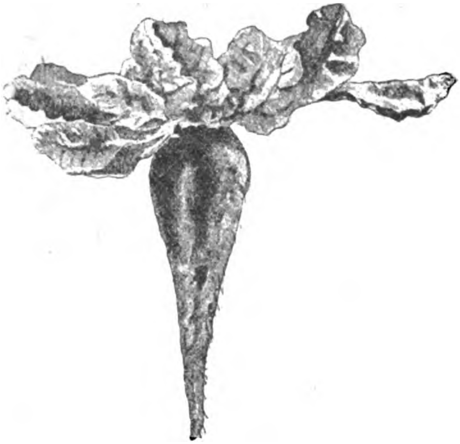

Figure 5.

Should the beet sugar industry continue to thrive, as it has for a few years past, it would seem reasonable to expect the perfecting of a harvester that will top, dig, and elevate the beets to a wagon. Such a machine would not present the difficulties in manufacture, or require the power to operate, of some of the farm machinery in use on the coast.

The following prices of implements for sugar beet culture were given by one manufacturing firm for the spring of 1892:

Subsoiler	$12.
Perfect one horse drill	10.
Cultivator	20.
Planter	30.
Harvester	40.

These implements kept housed and painted—used simply for beet culture—would last many years with little expense for repairs.

It will be noticed in Mr. Gird's article that by the use of a hoe made especially for the purpose, the beet puller, horse rake for removing the leaves, that he has reduced the expense of harvesting about one half. In Nevada, where labor is high, machinery that has proved to be practical in the beet fields of California and Nebraska will render substantial aid in growing beets at a profit.

The beet cultivator (Figure 3.) could be used to do a certain amount of thinning by crossing the rows and afterwards thinning the bunches to one plant.

For farmers, the growing, or not growing, of sugar beets is purely a topic of business. They do not wish a factory because Utah or Nebraska has one—nor do they care to grow beets at a loss—but, if grown at all, for a fair profit on each and every acre. Beets must be grown for a certian number of years to make the investment profitable. Good beets in sufficient quantity and other necessities must be guaranteed before capital will invest. A plan is necessary for the 2,500 acres, or more, required for the beets, and two or three times this amount in addition, to provide, to some extent at least, for a rotation of crops, as it is not desirable to grow beets continuously on the same land.

Some cities after securing one manufacturing plant find it less difficult to induce others to locate. With several plants in operation railroads can afford to make better rates for the shipment of raw material and manufactured goods.

BEET CULTURE AND SUGAR PLANT.

BEET CULTURE.

1. What time of year do you plow, and how deep?
2. Do you subsoil, if so—best plow ?
3. What kind of seeder do you use ?
4. How many pounds of seed per acre ?
5. How many days from seeding to ripening ?
6. Do you determine when ripe by chemical analysis, are other methods certain ?
7. What form of harvester do you use ?
8. What kind of fertilizers would you recommend ?
9. Rows are placed how far apart ?
10. Distance between beets in the row ?
11. What do you consider best cultivator ?
12. How many irrigations per season ?
13. How many days do you run your sugar plant ?
14. Do you have any freezing during the sugar beet campaign ?

SUGAR PLANT.

1. For using 300 tons of beets per day and 100 days campaign, what amount of capital should be used in the plant ?

2. With the necessary cash, a sufficient amount of beets guaranteed having the required sugar content, skilled labor, what other prominent requisites should be considered in starting a plant?
3. Will it ever pay, under any conditions, to work medium sized beets, carrying less than 12 per cent sugar?
4. Do you consider it safe—one season with another—to estimate for a sugar plant 15 tons per acre on 2,000 acres, giving 30,000 tons for 100 days campaign at 300 tons per day?
5. What is the lowest per cent in beets that you care to work?
6. On what terms will you erect a sugar plant in Nevada?

The following article was contributed by Mr. Richard Gird of Chino, California, in reply to above questions on culture and sugar plant. It will prove of interest to our farmers who desire to grow beets in quantity, provided a factory should be erected:

BEET CULTURE.

1. Plow in the fall; depth depends on previous cultivation. It is not judicious to turn up too much cold ground, not more, I should say, than two inches after a depth of six inches has been reached in one season. On new land, I should plow eight inches, the second year 9 to 10 inches, and so increasing each year until a foot or fourteen inches has been reached, according to the depth and character of the underlying soils.

2. Subsoiling is a benefit on most soils, but only to stir the land and render it permeable for the tap-root of the sugar beet, which the deeper it can penetrate the soil, the better. In many instances where the soil will admit the tap-root of the beets, they have been known to penetrate 10 to 12 feet, thus drawing the moisture and nutriment from the underlying soils, which could not have been reached otherwise, and which, of course, is an important point, as it thus brings to the surface for future use the plant food of the underlying stratas of soil that could be reached in no other way. Shallow soils with hardpan near the surface or with heavy underlying stratas of soil or clay should in some way be broken up or deeply stirred, so as to permit the tap-root of the sugar beet to go down as deep as possible.

3. Previous to my commencing sugar beet culture on a large scale, I planted for three years, experimenting with the different kinds of soils and seeds, under different conditions of planting, at different times during the season, analyzing continuously, and finally determined on three varities of seed—the variety of Desprez seed, which we call the No. 5, and which produces a very long cylindrical beet, made so by cultivating the soils to one meter in depth and selection for many generations, until that type of beet was established which goes deep into the soil; this makes a long beet with heavy tonnage and, at the same time, it is good in sugar. I plant this beet on the higher lands where the soil is loose and very permeable and of great depth; and where the tonnage would be lighter for the smaller variety of beets. This never fails to make a good sugar percentage, say 14 to 15 per cent. The next best variety, in my estimation, is the Kleinwanzlebener of which there are many kinds; the one that I have had the most experience with is the Vilmorin Improved Kleinwanzlebener which, although a much shorter beet, not penetrating so deep into the soil, is a thrifty, hardy variety, and has produced as high as thirty tons to the acre with 15 per cent sugar on my plantation, and is much liked by the farmers and also by the factory. I have also on my lower, extremely damp and heavy soils, where, according to rule, I should expect low purity and sugar, been very successful with Vilmorin Amelioree, which is a beet with a smaller tonnage, but good in purity and sugar and has never failed to make good workable beets, althongh in many instances the tonnage has been rather light. Last year, from the damp lands, I brought in many wagon loads of this beet that analyzed as high as 22 per cent in sugar, with the tonnage quite satisfactory. Another variety, fully tested last year and much liked, is the kind marked L. R. from LeMaire Frere et Soeur, which in addition to high tonnage seems to be exceptionally high in purity as well as fair in sugar, going the same in sugar as the Kleinwanzlebener, with purity much higher, under the same conditions. The character of this beet is cylindrical and much finer in shape than the Kleinwanzlebener.

I should advise those who are going into the sugar beet business extensively, to test their soils thoroughly with the different varities of seed, at different times of planting and mode of cultivatoin. I find that there is no agricultural product that needs so careful attention and consideration by the agriculturalist, perhaps, I may say in a scientific way, as the sugar beet. Neither theory nor practice brought from Europe have been found reliable as to the new conditions of climate and soil, especially on the Pacific coast, for instance, much careful experimenting has been done with reference to the necessary and adequate rainfall for the perfect development of the sugar beet in Europe, and without which a failure of the crop is expected, whereas, here, beets are raised that never see a drop of rain from the time they are planted until they are harvested, and that with the most perfect success.

In planting, I have used, so far, a drill-seeder made by myself, and upon the forced drill principle, that will not clog and plants the seed in given distances apart, in drills from 17 to 22 inches. I have found this seeder very satisfactory and with it can plant from 10 to 18 pounds of seed to the acre, my best success has been with 14 pounds which I find ample for proper planting. The depth at which it should be planted depends upon the condition of the soil, the time of year, etc., from one inch, perhaps, to two inches, light warm soils deeper, heavy, cold damp soils one inch is sufficient; this is a matter of great importance. They should also be planted at a uniform depth, so that they will come up at the same time, which makes the thinning much more satisfactory, as the beets will be the same size to thin and will ripen at the same time in the fall.

5. The time of growth to maturity of the sugar beet—from the time of seeding to the time of ripening—depends to a great extent on the variety of seed and conditions of the soil, and is very variable. I should say, on an average, it is about four to four and a half months. Some varities ripen much earlier than others, under the same conditions, but the above will be about the average for the varities of seed that I have tried on my soils.

6. To determine whether a beet is ripe or not and ready to be harvested and to go into the factory, the only sure test is the chemical analysis. The appearance of the top of the beet is somewhat of a guide, of course, but it may be a fallicious one, as I have found by actual test, that even a few foggy days will run down the percentage of sugar sometimes as much as two per cent. I, therefore, depend entirely upon chemical analysis to determine

when the beets are fit to go into the factory. Early rains in the fall, if they are at all warm, will reduce the percentage of sugar very rapidly, and, in some cases, by promoting the second growth, may render a good beet unfit for the factory. Very cold rains don't make so much difference.

7. The question of mechanical harvesting of sugar beets has not, so far, been thoroughly determined; none of the foreign or domestic harvesters that have been tried have fully answered the purpose. The most complete one is the puller invented by H. B. Martin, of Chino, which will pull in a most complete manner, as a team is driven along, all the large and small beets and deliver them on the top of the ground as they come from the machine. He is now trying to improve upon this machine by mechanically handling the beets to some receiver to save the picking up from the ground, etc. No topper has yet been invented in California or elsewhere, I think, that will work beets, although I expect it will be accomplished before long, as many inventors are working upon it and some of them will undoubtedly perfect a machine in the near future, when the cost of harvesting beets will be reduced by one-half, from the old plan of plowing out and topping with a knife. I adopted, last year, in connection with the puller above mentioned, a plan of topping with a hoe bent to a curve like an adz, so as to cut the top of the beets square, by which plan I find one man will top about as much as six with a knife. Following the toppers, I have a horse rake to remove the leaves that have been topped, then comes the puller. By this plan, I have already reduced the expense almost one-half, and consider it a very satisfactory method.

8. I have not, so far, experimented very much with fertilizers, as my soils are all virgin and rich; most soils, of a sandy nature, common barnyard manure will be the very best. I think it should be pretty well rotted, and, I think, that with the sunshine and warm soils we have here in Southern California, we need not fear putting on any kind of raw manures. In Europe, they require to figure so closely on the percentage and purity, that they have not made a success of any but the nitrogenous, well-rotted prepared fertilizers.

9. The distance between the beets in the row varies very much, according to the character of the soil and the beet. The No. 5

and the Kleinwanzlebener should have a larger space left than the Vilmorin Amelioree. I should say, ordinarily, ten to twelve inches for the No. 5 and Kleinwanzlebeuer, and eight to ten inches for the Vilmorin Amelioree and some of the smaller varities.

11. We have got up a cultivator here that cultivates four rows at a time and has been called to the attention of the Moline Plow Company, by Mr. Luitweiler, and they are now making them in a very perfect manner; their machine has two sets of teeth, one set cutting the weeds like a hoe, and the others stirring the ground. I use the hoe teeth at first, to clear the ground of weeds, and, when the field is ready to lay by, I use the stirring teeth to loosen up the ground, and then the field is left until the harvest.

12. I do not irrigate my beets, nor do any of the other sugar beet growers in California. It has been the experience with irrigated beets, so far, that they have not been satisfactory in sugar and purity, and consequently, have not been a success. I should think, that if you had soils deep and porous that will hold a good deal of moisture, a thorough spring irrigation, before planting, would carry your beets to maturity, as the tap-roots sink deep into the soils and hunt all the moisture that is to be found. The sugar beet is a very hardy plant, that adapts itself to conditions with more success than almost any other. I should advise the attempt to raise them with one thorough irrigation before planting, but would not advise, under any circumstances, more than one irrigation after.

13. The length of time a Sugar Factory Plant will run depends of course upon the amount of beets furnished to it and the rapidity with which they are worked. Last year the Chino Valley Beet Sugar Factory worked over 350 tons of beets per day, running through about 28,000 tons of beets, which took from the 11th of July to the 10th of October. It is expected, however, that we will run hereafter, from the middle of July until the middle of November or the first of December. The Factory is to be enlarged this year to double its present capacity, or abont 600 tons per day, and we expect to run through about 50,000 to 60,000 tons, which will take about 100 days. Of course, some stoppages have to be taken into consideration, but in this country, where there is no bad weather, and the beets can be put directly from

the ground into the factory, we don't figure on much lost time.

14. From the answers to the above questions, you will see that I don't calculate on any frosts during the sugar beet campaign, as we don't have any frosts in California worth considering until December at the earliest. Beets are not injured by any common light frosts.

SUGAR PLANT.

1. As to the question of the cost of a sugar plant, it is a very hard one to answer. Much depends upon the character of the building, freights, cost of material and so forth. The way factories are built now, 300 tons is rather an odd size. With the ordinary slicer and diffusion batteries and machinery to correspond, it is intended to work 330 to 350 tons of beets per day, which would cost, I suppose, set up in a wooden building, about $400,000.

2. One of the first and main requisites is a large amount, say 2,000,000 gallons of pure, cool water per day; this is an absolute necessity. Cheap fuel is also a question of so much importance that coal above $7 per ton would be a very heavy inroad on what should be the fair profits of the manufacturer.

As to skilled labor, a good practical superintendent with an assistant and about ten employees skilled in diffusion, carbonizing and boiling, with a good chemist in the laboratory, and a good and competent man in charge of the machinery, would be all sufficient to start the machinery and break in new men in all the other departments, training others into the skilled part of the business. There is no longer any uncertainty about the manufacturing part.

3. I should hardly ever expect to work beets as low as an average of 11 per cent, still, a beet of 12 per cent and under, with a purity of 80 per cent and over, could be worked to a profit, and the profit increases very rapidly with the increase of the percentage, and decreases in proportion; the exact ratio I have not now on hand—can be found in the tables of the European reports.

4. I should hardly consider it safe to calculate on an average of fifteen tons to the acre, especially for the first few years. It would be better, if you wish to get 30,000 tons for the 100 days

campaign of 300 tons of beets per day, to plant 2,500 acres in place of 2,000.

5. As to this question, we have placed our minimum percentage, below which we never calculate to work beets, at 12 per cent, although, as I mentioned above, I think they could be worked to a profit, perhaps, as low as 11 per cent, if the purity was 80 per cent and upwards.

6. The factory at Chino, was built and is run by the Chino Valley Beet Sugar Company, a branch of the Oxnard Beet Sugar Company, who have two factories in Nebraska besides this one here. I believe, however, that they are not anxious to build another factory until they have exhausted and filled those they now occupy; which they are proceeding to do in the Chino Valley factory by enlarging it this year to double or 600 tons per day. I have not heard that they are prepared in their agricultural department in Nebraska to enlarge the factory there. I expect to deliver at the Chino factory this coming season enough beets for the fall campaign of 600 tons of beets per day. Shall have about 5,000 acres in beets. We expect the thinning will commence early in April and the harvesting about the middle of July; when the beets will be worked as delivered, fresh from the ground, not being kept in the bins, in any case, longer than four days; this is a great advantage, as beets work much easier, diffusing and crystalizing much better when they have properly ripened, both of which conditions can be got to perfection in this climate.

If there is anything further in which I can be of assistance to you, I shall be glad to do so.

If you could pay me a visit during the coming campaign, shall be pleased to entertain and consult with you on all points of interest.

Yours respectfully,

RICHARD GIRD.

The same list of questions on culture and sugar plant were sent to an eastern capitalist interested in beet culture, who replied as follows:

Mr. R. H. McDowell, Reno, Nevada,—DEAR SIR:—I have been on an extended trip, and so busy that I did not have time to answer you until now, but trust that the answers to your questions will reach you in time. Regarding your questions of beet culture it depends entirely upon the location where the plant is situated; for instance, plowing commences much earlier in California than it does in Nebraska. But I shall try and answer your questions in a general way, to the best of my ability, without particularizing.

It is advisable to commence plowing from two to four inches in depth in the summer or early fall, as soon as the crop of wheat, rye, oats, or millet has been removed, which generally precedes beets. The object of this early, shallow plowing is to start the weeds growing. Later on, in October, by a deep plowing, say 10 or 12 inches, bury them. It is also advisable to sub-soil so as to get a seed bed of from 12 to 16 inches. We use here a superior drill made in Springfield, Ohio, which gives entire satisfaction. I would advise planting about 20 pounds to the acre. The beet requires about 150 days to ripen, and as a gederal rule the beet is ripe when the leaves commence turning yellow and drop to the ground. It is also advisable to take samples through a field and have them analyzed in the laboratory of the factory. As yet, we have not found a perfect harvester, but there are several agricultural companies at work on such an implement, and I hope we will obtain some tangible results the coming year. Regarding fertilizers, we have not used any to date, but are making experiments this year and will probably be able to give you information on that subject by the end of the year. We find 18 inches between the rows, an 6 and 8 inches between the plants in the rows, give the best results. We have not irrigated, as yet, on any of our fields; but for this information I would advise you to apply to the Lehi factory, in Utah, who irrigate largely. As a rule a sugar plant should run a hundred days. Beets must be protected from frost by piling them up, and covering the piles with dirt.

A sugar plant using 300 tons of beets per day, with all the latest modern improvements, will cost in the neighborhood of $400,000. Besides the necessary capital and a guaranteed supply of beets, with the skilled labor necessary to run a factory, it is necessary to have an abundance of water, as a 300 ton factory uses about 2,000,000 gallons per day in the operation of the factory. Of course, this water is not used up, but that amount is required to carry on the various operations of the factory, and can be returned in about the same condition that it was received, after passing through the factory. You should have a supply of cheap fuel, reasonable transportation, as well as lime-stone, which is used in quantities varying from 30 to 40 tons per day. Of course there are a thousand details besides these, which I cannot go into at the present moment, but the above are the general requisites. I do not believe it would pay to manufacture any beets containing less than 12 per cent of sugar. I think it very improbable that, during the first two or three years, you can obtain 30,000 tons of beets from 2,000 acres. If you did accomplish it, it would be the first time it has ever been done in the history of the industry.

CHEMICAL SECTION.

The beets sent in this year for analysis have given better results than for 1891. This is in a measure due to better cultivation and a better knowledge of the requirements of the industry. The beets were of good medium size, thus showing that the farmers are opening their eyes to the "size question." This is one of the most important things to thoroughly understand when beets are raised for sugar. It has been proven conclusively in our experiments here and by all Stations that have investigated this question that the beet for profit is the 1½ to 2½ pound beet, and it costs no more to raise this than the larger.

The beet raising industry is surely one adapted to Nevada, both from the farmer's and the manufacturer's standpoint, our soil, climate and other conditions are favorable.

Following are analyses of beet raising soils of the best sections of France, [Table No. 1.] and, for the purpose of comparison, analyses of Nevada soils are also given [Tables Nos. 2, 3, 4.]; the latter which, Number 4, is from the Experiment Station farm. This soil, as seen from an inspection of the table of beet analysis, is particularly adapted to beet raising, producing beets containing from 12 to 23.80 per cent sucrose:

NO. 1.—ANALYSES OF FRENCH SOILS.

Number of experiments	1	2.	3	4
	Dep. Somme.	North	Aisne.	Somme.
Organic substances	5.600	4.840	5.70	8.200
Silica	81.800	82.500	79.00	42.000
Alumina	7.240	8.620	8.50	3.91
Lime	0.510	0.420	0.25	23.220
Peroxide of iron	2.880	2.180	3.50	2.310
Phosphoric acid	0.070	0.077	trace	0.385
Potassa	0.064	0.140	"	0.044
Soda	0.085	"	2.85	0.058
Carbonic acid	0.400	0.700		19.050
Various elements	1.851	1.523		0.823
In this there existed for the total—	100.000	100.000	100.000	100.000
Nitrogen	0.088	.120	0.154	0.270
Ammonia	0.013	.030	0.016	0.010
Sand	72.100	80.000	62.000	35.770
Clay	22.000	9.000	30.000	10 to 12000

NO. 2.—NEVADA SOIL.

Soil marked		**No. 2.**
Serial number		**12**
Moisture	**per cent.**	**1.003**
Insoluble silica	"	**58.064**
Hydrated silica	"	**16.058**
Soluble silica	"	**·147**
Sesquioxide of iron Fe_2O_3	"	**3.116**
Alumina Al_2O_3	"	**3.875**
Phosphoric acid P_2O_5	"	**.125**
Lime CaO	"	**7.492**
Magnesia MgO	"	**3.081**
Patash K_2O	"	**.364**
Soda Na_2O	"	**.627**
Sulphuric acid SO_3	"	**.075**
Chlorine Cl	"	**.004**
Carbonic acid CO_2	"	**5.469**
Volatile and organic matter	"	**1.023**
Total		**100.473**
Nitrogen N		**.086**
Air dried soil contains—		
Stones		**3.03**
Coarse gravel		**4.16**
Fine gravel		**7.84**
Fine natural		**84.97**
Total		**100.00**

NO. 3.—NEVADA SOIL.

Soil marked		**E. No.3.**
Serial number		**3**
Moisture	**per cent.**	**.613**
Insoluble silica	“	**62.217**
Hydrated silica	“	**8.899**
Soluble silica	“	**.064**
Sesquioxide of Iron Fe_2O_5	“	**1.679**
Alumina Al_2O_3	“	**1.099**
Hhosphoric acid P_2O_5	“	**.040**
Lime CaO	“	**9.580**
Magnesia MgO	“	**2.332**
Potash K_2O	“	**.016**
Soda Na_2O	“	**.021**
Sulphuric Acid SO_3	“	**.016**
Chlorine Cl	“	**.030**
Carbonic acid Co_2	“	**8.313**
Volatile and organic matter	“	**4.209**
Mangano-Manganic oxide Mn_3O_4	“	**Trace**
Total		**99.129**
Nitrogen N	“	**.078**
Stones [Mechanical analysis]	“	**2.29**
Coarse gravel	“	**6.71**
Fine gravel	“	**10.93**
Fine material	“	**80.07**
		100.00

NO. 4.—EXPERIMENT STATION.

Soils marked		**Alfalfa.**
Serial number		7.
Moisture	per cent.	2.204
Insoluble silica	"	61.843
Hydrated silica	"	17.175
Soluble silica	"	.076
Sesquioxide of iron Fe O	"	9.058
Alumina Al O	"	1.333
Phosphoric acid P O	"	.019
Lime Ca O	"	2.801
Magnesium Mg O	"	.574
Potash K O	"	.128
Soda Na O	"	.607
Sulphuric acid S O	"	.060
Chlorine Cl	"	.012
Carbonic acid C O	"	.202
Volatile organic matter	"	2.618
Total		98.710
Nitrogen N		.056
Mechanical analysis—		
Stones		9.02
Coarse gravel		7.36
Fine gravel		27.00
Fine material		56.62
Total		100.00

With the exception of the alkali soils our soil is well adapted for beet growing, and can be found in tracts amply large for the purpose on the line of the Central Pacific, Virginia and Truckee and Carson and Colorado railroads. As to climate, we have everything that could be desired. Here we have almost continual sunshine and long hot days, with cold, clear nights. What better could we have for sugar development? No long, dreary, cold rains, but for six months, almost continually, the perfection of weather.

For water we have irrigation, a system by which the amount of moisture can be regulated at pleasure, and no droughts need be feared, no long damp spells. Irrigation of beet crops is directly opposed to French and German teachings, but experiments here and in Utah have proven it successful, and we are able to produce beets of higher sucrose percentage than either France or Germany. Beets raised here would readily command at factory $5 per ton, which, with an average of fifteen tons per acre, at a cost of $35 per acre, would net $40 per acre. Thus we see that with a factory near, the Nevada farmer could raise beets at a good profit.

Beets could be produced in abundance, we have tracts where 10,000 to 15,000 acres of fine soil can be planted to beets, which would yield from 15 to 20 tons per acre.

Good water supplies are obtainable on the Truckee, Humboldt or Carson rivers.

Shipping facilities are good in all places where other conditions are most favorable. Freight rates are somewhat high, but special rates could be secured.

As to the quality of the beets little need be said, as the results of analysis speak for themselves. In quality, however, we rival any State of the Great Northwest.

Of all the community the one deriving the most benefit is the farmer, and the farmer is the coming man of the times. In America, like all other countries, the man who tills the soil has occupation for but about half the year. This ending at just the time the beet harvest begins. The factories thus work during the winter and give intellectual employment to all interested, as they acquire notions of chemistry, mechanics, etc., which they would not otherwise obtain.

Beet raising would compel higher farming and thorough cultivation. To keep the soil from exhaustion, the most parts of the beets must be returned either directly or indirectly to the soil. The tops and crowns, together with the pulp from which sugar has been extracted, are most excellent food for cattle and hogs, thus stock raising in the right direction would be introduced and Nevada would in a measure be able to stop the great importation of Omaha and Kansas City hog products. Rotation of crops would be absolutely necessary, and it has been found that the grain crop following the beet crop is improved to a wonderful extent.

Thus beet raising would revolutionize Nevada agriculture, a change which must come if this State is to have a future.

We have the facilities and the necessary capital is not far away. We trust that this great industry may be inaugurated, and, hand in hand with that of diarying, lift this State from its present position to a plane of prosperity where she may compete with any State of the Union.

ERRATA.

Page 3, line 10—"*Station Ground sand*" should read "*Station Grounds and.*"

Pages 4, 5, 18, 21—"*varities*" should read "*varieties.*"

Page 11—"*inflamable*" should read "*inflammable.*"

Page 16—"*ctltivation*" should read "*cultivation.*"

Page 20—"*stratas*" should read "*strata.*"

Page 22—"*cultivatoin*" should read *cultivation.*"

Page 22—"*fallicious*" should read "*fallacious.*"

NO. 5.—SHOWING ANALYSES OF

Station number...	Grower.	Postoffice Address.	Seed from	Variety of Beets.
301	Station Farm..	Reno, Washoe Co....	U. S. Department..	Vilmorin..............
302	....do....do...	.. do....do....do....	Chino, California..	Simon Le grande.......
303	....do....do...	.. do....do....do....	....do......do	Vilmorin Amelioree.....
304	....do....do...	.. do....do....do....	....do......do	......do........do......
305	....do....do...	.. do....do....do....	....do......do	......do........do......
306	....do....do...	.. do....do....do....	Grand Island, Neb.	Desprez...............
307	....do....do...	.. do....do....do....	....do......do	......do...............
308	....do....do...	.. do....do....do....	....do......do	......do...............
309	....do....do...	.. do....do....do....	Chino, California..	Florimond Desprez.....
310	....do....do...	.. do....do....do....	....do......do	......do........do......
311	....do....do...	.. do....do....do....	....do......do	......do........do......
312	....do....do...	.. do....do....do....	U. S. Department..	Kleinwanzlebener.......
313	....do....do...	.. do....do....do....	....do......do	......do...............
314	....do....do...	.. do....do....do....	....do......do	......do...............
315	....do....do...	.. do....do....do....	....do......do	Improved Vilmorin......
316	....do....do...	.. do....do....do....	....do......do	......do........do......
317	....do....do...	.. do....do....do....	....do......do	......do........do......
318	....do....do...	.. do....do....do....	....do......do	......do........do......
319	....do....do...	.. do....do....do....	Chino, California..	Simon Le grande.......
320	....do....do...	.. do....do....do....	....do......do	......do........do......
321	....do....do...	.. do....do....do....	....do......do	......do........do......
322	....do....do...	.. do....do....do....	Grand Island, Neb.	Desprez...............
323	....do....do...	.. do....do....do....	....do......do	......do...............
324	....do....do...	.. do....do....do....	....do......do	......do...............
325	....do....do...	.. do....do....do....	Watsonville, Cala..	Verb. Kleinwanzlebener.
326	....do....do...	.. do....do....do....	....do......do	......do........do......
327	....do....do...	.. do....do....do....	....do......do	......do........do......
328	....do....do...	.. do....do....do....	....do......do	....
329	....do....do...	.. do....do....do....	....do......do	......do........do......
330	....do....do...	.. do....do....do....	U. S. Department..	Vilmorin..............
331	....do....do...	.. do....do....do....	....do......do	......do...............
332	....do....do...	.. do....do....do....	....do......do	......do...............
333	....do....do...	.. do....do....do....	....do......do	Kleinwanzlebener.......
334	....do....do...	.. do....do....do....	....do......do	......do...............
335	....do....do...	.. do....do....do....	....do......do	......do...............
336	....do....do...	.. do....do....do....	Grand Island, Neb.	Desprez...............
337	....do....do...	.. do....do....do....	....do......do	......do...............
338	....do....do...	.. do....do....do....	....do......do	......do...............
339	....do....do...	.. do....do....do....	Chino, California..	Simon Le grande.......
340	....do....do...	.. do....do....do....	....do......do	......do........do......

BEETS FOR SEASON OF 1892.

Time of Planting.	Time of Harvesting.	Kind of Soil.	Weight of Beet		Per ct. of Total Solids	Per cent of Sucrose	Purity......
			Pounds....	Ounces.....			
	Sep. 27, 1892.	Sandy loam, gravel and clay.	....	10.75	15.50	10.20	64.61
May 18, 1892.	do	do ... do	....	16.75	15.30	10.30	67.31
do	Sep. 2, 1892.	do ... do	....	7⅛	......	14.96	......
do	do	do ... do	....	13⅜	15.80	12.50	79.10
do	do	do ... do	1	8.75	16.80	13.80	82.62
May 11, 1892.	do	do ... do	....	4.50	16.80	13.20	78.57
do	do	do ... do	1	7.25	16.80	13.20	78.57
do	do	do ... do	....	8	16.80	13.20	78.57
May 18, 1892.	do	do ... do	1	5 1-16	15.60	13.00	83.34
do	do	do ... do	....	5⅝	15.60	13.00	83.34
do	do	do ... do	....	9⅞	15.60	13.00	83.34
May 10, 1892.	do	do ... do	....	10½	18.20	16.40	90.10
do	do	do ... do	1	1⅞	18.20	16.40	90.10
do	do	do ... do	1	1 11-16	18.20	16.40	90.10
do	do	do ... do	....	9¼	17.40	14.80	85.08
do	do	do ... do	....	4½	17.40	14.80	85.08
do	do	do ... do	....	1 5-16	17.40	14.80	85.08
do	do	do ... do	....	15¼	17.40	14.80	85.08
May 18, 1892.	do	do ... do	....	10⅞	18.30	16.10	87.97
do	do	do ... do	....	9¼	18.30	16.10	87.97
do	do	do ... do	....	6 13-16	18.30	16.10	87.97
do	do	do ... do	....	15	17.10	14.50	85.00
do	do	do ... do	....	6 3-16	17.10	14.50	85.00
do	do	do ... do	....	5½	17.10	14.50	85.00
do	do	do ... do	....	4½	18.00	15.80	87.79
do	do	do ... do	....	9¾	18.00	15.80	87.79
do	do	do ... do	....	12¾	18 00	15.80	87.79
		do ... do	1	8 3-16	21.00	18.80	89.53
July 9, 1892.	do	do ... do	1	11	22.00	19.30	87.74
May 10, 1892.		do ... do	....	12¾	19.20	15.50	80.72
do		do ... do	....	9½	19.20	15 50	80.72
do		do ... do	....	7 9-16	19.20	15.50	80.72
do		do ... do	....	11 15-16	21.60	18.80	87.03
do		do ... do	....	9 7-16	21.60	18.80	87.03
do		do ... do	....	4 5-16	21.60	18.80	87.03
May 18, 1892.	Sep. 12, 1892.	do ... do	....	13 15-16	20.00	18.20	91.01
do	do	do ... do	....	5 15-16	20.00	18.20	91.01
do	do	do ... do	....	8	20.00	18.20	91.01
do	do	do ... do	....	15 15-16	21 20	18.50	87.28
do	do	do ... do	....	10¼	21.20	18.50	87.28

NO. 5.—SHOWING ANALYSE

Station Number	Grower.	Postoffice Address.	Seed from	Variety o
341	**Station Farm**	Reno, Washoe Co	Chino, California	Simon Le gr
342	do...do	do...do...do	do...do	Vilmorin Am
343	do...do	do...do...do	do...do	do
344	do...do	do...do...do	do...do	do
345	do...do	do...do...do	Watsonville, Cala.	Verb. Kleinw
346	do...do	do...do...do	do...do	do
347	do...do	do...do...do	do...do	do
348	do...do	do...do...do	do...do	Imp. Kleinw
349	do...do	do...do...do	do...do	do
350	do...do	do...do...do	do...do	do
351	do...do	do...do...do	U. S. Depart. No. 1	Improved Vi
352	do...do	do...do...do	do...do	do
353	do...do	do...do...do	do...do	do
354	do...do	do...do...do	U. S. Depart. No. 2	Kleinwanzleb
355	do...do	do...do...do	do...do	do
356	do...do	do...do...do	do...do	do
357	do...do	do...do...do		Florimond D
358	do...do	do...do...do		do
359	do...do	do...do...do		do
360	do...do	do...do...do	Grand Island, Neb.	Desprez
361	do...do	do...do...do	do...do	do
362	do...do	do...do...do	do...do	do
363	**R. Sadler**	Eureka, Eureka Co		Verb. Kleinw
364	do...do	do...do...do		do
365	do...do	do...do...do	Watsonville, Cala	do
366	do...do	do...do...do	do...do	do
367	do...do	do...do...do	do...do	do
368	do...do	do...do...do	do...do	do
369	do...do	do...do...do	do...do	do
370	do...do	do...do...do	do...do	do
371	do...do	do...do...do	do...do	do
372	do...do	do...do...do	do...do	do
373	**J. G. Young**	Wabuska, Lyon Co		Klein Verb.
374	do...do	do...do...do		do
375	**Station Farm**	Reno, Washoe Co	Watsonville, Cala	Verb. Kleinw
376	do...do	do...do...do	do...do	do
377	do...do	do...do...do	do...do	do
378	do...do	do...do...do	U. S. Department	do
379	do...do	do...do...do	do...do	do
380	do...do	do...do...do	do...do	do
381	do...do	do...do...do	do...do	Vilmorin Am
382	do...do	do...do...do		do
383	do...do		Grand Island, Neb.	Desprez
384			do...do	do
385			do...do	do
386				

ETS FOR SEASON OF 1892.—*Continued.*

Time of Planting.	Time of Harvesting.	Kind of Soil.	Weight of Beet		Per ct. of Total Solids	Per cent of Sucrose	Purity
			Pounds	Ounces			
May 10, 1892	Sep. 12, 1892	Sandy loam, gravel and clay.		4 15-16	21.20	18.50	87.28
do	do	do.......do	1	14⅛	19.00	17.00	89.45
do	do	do.......do		15 15-16	19.00	17.00	89.45
do	do	do.......do		5⅝	19.00	17.00	89.45
do	do	do.......do		12⅛	20.40	17.80	87.25
do	do	do.......do		7 5-16	20.40	17.80	87.25
do	do	do.......do		4 11-16	20.40	17.80	87.25
do	do	do.......do		14½	18.00	16.90	93.88
do	do	do.......do		6 11-16	18 00	16.90	93.88
do	do	do.......do		4 11-16	18.00	16.90	93.88
May 18, 1892	do	do.......do		11 1-16	20.20	18.20	90.10
do	do	do.......do		12	20.20	18.20	90.10
do	do	do.......do		5 1-10	20.20	18.20	90.10
do	do	do.......do		11¼	21.20	20.00	94.34
do	do	do.......do		7¾	21.20	20.00	94.34
do	do	do.......do		5⅞	21.20	20.00	94.34
	Sep. 14, 1892	do.......do		14 7-16	19.00	17.00	89.45
	do	do.......do		12 13-16	19.00	17.00	89.45
	do	do.......do		6⅝	19.00	17.00	89.45
May 11, 1892.		do.......do	1	4¼	19.00	17.10	89.99
do		do.......do		12 7-16	19.00	17.10	89.99
do		do.......do		4⅜	19.00	17.10	89.99
		do.......do	1	12	21.40	15.20	71.02
		do.......do	1	10	18.00	13.50	74.99
			1	12½	13.40	9.50	56.57
			1	12	15.20	10.50	69.09
			2	11	12.20	5.50	45.07
			1	10½	14.20	9.00	56.34
			1	11	15.80	9.50	60.10
			1	15	13.60	8.30	61.04
			1	15	17.40	13.00	74.72
			2	4	11.80	9.00	76.26
May 20, 1892.	Oct. 8, 1892	Sandy loam.	2	5	12.40	8.00	64.52
do	do	do.	1	12	17.00	11.50	83.03
May 18, 1892.	Oct. 11, 1892.	Sandy loam, gravel and clay		10 9-16	22.20	18.50	83.33
do	do	do.......do		15	22.20	18.50	83.33
do	do	do.......do		15 7-16	22.20	18.50	83.33
do	do	do.......do		13 5-8	20.40	18.20	89.22
do	do	do.......do		15¾	20.40	17.10	83.83
do	do	do.......do		10	20.40	21.50	94.88
do	do	do.......do	1	3½	21.20	20.10	97.02
do	do	do.......do	1	1¾	21.20	18.00	84 91
do	do	do.......do		12½	21.20	19.80	93.42
				15½	23.80	20.00	84.02
				9	23.80	23.00	96.62
			1	1	24.00	23.50	97.92

NO. 5.—SHOWING ANALYSES OF BI

Station number...	Grower.	Postoffice Address.	Seed from	Variety of Beets.
387				
388				
389				
390			U. S. Department	Improved Vilmorin
391			do...do	do...do
392			do...do	do...do
393	Station Farm	Reno, Washoe Co	Chino, California	Florimond Desprez
394	do...do	do...do...do	do...do	do...do
395	do...do	do...do...do	do...do	do...do
396	do...do	do...do...do	Watsonville, Cala.	Imp. Kleinwanzlebener
397	do...do	do...do...do	do...do	do...do
398	do...do	do...do...do	do...do	do...do
399	E. Mathews	do...do...do	Chino, California	Verb. Kleinwanzlebener.
400	do...do	do...do...do	do...do	do...do
401	do...do	do...do...do	do...do	do...do
402	do...do	do...do...do	do...do	do...do
403	do...do	do...do...do	do...do	do...do
404	Station Farm	do...do...do	do...do	Florimond Desprez
405	do...do	do...do...do	do...do	do...do
406	do...do	do...do...do	do...do	do...do
407	do...do	do...do...do	Watsonville, Cala	Imp. Kleinwanzlebener
408	do...do	do...do...do	do...do	do...do
409	do...do	do...do...do	do...do	do...do
410	do...do	do...do...do	Chino, California	Simon Le grande
411	do...do	do...do...do	do...do	do...do
412	do...do	do...do...do	do...do	do...do
413	do...do	do...do...do	U. S. Department	Kleinwanzlebener
414	do...do	do...do...do	do...do	do
415	do...do	do...do...do	do...do	do
416	do...do	do...do...do	Grand Island, Neb.	Desprez
417	do...do	do...do...do	do...do	do
418	do...do	do...do...do	do...do	do
419	do...do	do...do...do		Vilmorin Amelioree
420	do...do	do...do...do		do...do
421	do...do	do...do...do		do...do
422	do...do	do...do...do	Watsonville, Cala	Verb. Kleinwanzlebener.
423	do...do	do...do...do	do...do	do...do
424	do...do	do...do...do	do...do	do...do
425	do...do	do...do...do	U. S. Department	Improved Vilmorin
426	do...do	do...do...do	do...do	do...do
427	do...do	do...do...do	do...do	do...do
428	do...do	do...do...do	do...do	Kleinwanzlebener
429	do...do	do...do...do	do...do	do
430	do...do	do...do...do	do...do	do
431	do...do	do...do...do	Watsonville, Cala	Imp. Kleinwanzlebener
432	do...do	do...do...do	do...do	do...do

ETS FOR SEASON OF 1892.—*Continued.*

Time of Planting.	Time of Harvesting.	Kind of Soil.	Weight of Beet		Per ct. of Total Solids	Per cent of Sucrose	Purity
			Pounds	Ounces			
				14½	21.20	20.00	94.34
			1	3	21.20	20.80	98.12
				7	21.20	20.50	98.96
				13½	26.00	22.50	68.74
				10⅜	26.00	23.30	89.61
				9⅝	26.00	23.00	89.61
		Sandy loam, gravel and clay.		10⅝	22.60	20.00	88.49
		do do	1	1⅜	22.60	19.50	68.53
		do do	1	1 13-16	22.60	20.10	88.94
May 10, 1892.	Oct. 11, 1892.	do do	1	4½	22.60	20.60	91.15
do	do	do do		11	22.60	20.60	91.15
do	do	do do		8½	22.60	20.60	91.15
May 1, 1892.	Oct. 15, 1892.	Black loam, (heavy)	1	11	20.00	17.80	89.01
do	do		1	2	20.00	15.60	78.00
do	do			13	20.00	18.00	90.09
do	do			14½	22.50	19.20	85.32
do	do			14½	22.50	15.00	66.66
May 18, 1892.	Oct. 27, 1892.	Sandy loam, gravel and clay	1	8	18.20	16.20	89.00
do	do	do do	1	4½	18.00	16.80	93.40
do	do	do do	1	3½	18.20	15.00	82.41
May 10, 1892.	do	do do	1	1	19.50	16.10	82.56
do	do	do do		14	20.40	17.80	87.25
do	do	do do		11½	20.40	18.00	88.24
May 18, 1892.	do	do do	1	1½	20.40	17.60	86.27
do	do	do do		14½	20.40	16.10	93.35
do	do	do do		11½	20.40	16.50	80.90
do	do	do do	1	1	19.60	16.20	82.64
do	do	do do		10	19.60	17.20	87.74
do	do	do do		5½	19.60	19.50	99.47
do	do	do do		15	20.00	17.40	86.99
do	do	do do		11½	20.00	17.00	84.99
do	do	do do		9	20.00	18.40	92.00
do	do	do do		13	20.20	18.50	91.57
do	do	do do		13	20.20	17.00	84.13
do	do	do do		11½	20.20	17.50	86.61
do	do	do do		12	21.80	17.10	78.43
do	do	do do		9	21.80	15.50	71.09
do	do	do do		8	21.80	16.10	73.84
do	do	do do		8½	20.90	18.50	88.53
do	do	do do		9	20.90	17.50	83.73
do	do	do do		7½	20.90	17.50	83.73
May 10, 1892.	Nov. 3, 1892.	do do	1	8 3-16	21.10	18.80	89.10
do	do	do do	1	11	22.00	19.30	87.74
do	do	do do	1	15-16	21.20	15.00	70.76
do	do	do do	1	5 9-16	16.80	15.10	89.88
do	do	do do	1	5-16	18.40	17 50	95.10

NO. 5.—SHOWING ANALYSES OF BE

Station number...	Grower.	Postoffice Address.	Seed from	Variety of Beets.
433	Station Farm	Reno, Washoe Co	Watsonville, Cala.	Imp. Kleinwanzlebener
434	do do	do do do	U. S. Department	Vilmorin
435	do do	do do do	do do	do
436	do do	do do do	do do	do
437	do do	do do do	Chino, California	Simon Le grande
438	do do	do do do	do do	do do
439	do do	do do do	do do	do do
440	do do	do do do	do do	Florimond Desprez
441	do do	do do do	do do	do do
442	do do	do do do	do do	do do
443	do do	do do do	Grand Island, Neb.	Desprez
444	do do	do do do	do do	do
445	do do	do do do	do do	do
446	do do	do do do	Chino, California	Vilmorin Amelioree
447	do do	do do do	do do	do do
448	do do	do do do		do do
449	do do	do do do	Watsonville, Cala	Verb. Kleinwanzlebener
450	do do	do do do	do do	do do
451	do do	do do do	do do	do do
452	do do	do do do	U. S. Department	Kleinwanzlebener
453	do do	do do do	do do	Imp. Kleinwanzlebener
454	do do	do do do	do do	Desprez
455	B. F. Leete	do do do		do
456	do do	do do do		do
457	do do	do do do		do
458	do do	do do do		do
459	do do	do do do		do
460	do do	do do do		do
461	do do	do do do		do
462	do do	do do do		do
463	do do	do do do		do
464	Station Farm	do do do		Verb. Kleinwanzlebener
465	do do	do do do		do do
466	do do	do do do		do do
467	do do	do do do		Imp. Kleinwanzlebener
468	do do	do do do		do do
469	do do	do do do		do do
470	do do	do do do		Verb. Kleinwanzlebener
471	do do	do do do		do do
472	do do	do do do		do do
473	do do	do do do	Watsonville, Cala	do do
474	do do	do do do	Chino, California	Gebruder
475	do do	do do do	do do	do
466	do do	do do do	do do	do
477	Henry Fish	Eureka, Eureka Co	Grand Island, Neb.	Desprez
478	do do	do do do	do do	do

ETS FOR SEASON OF 1892.—*Continued.*

Time of Planting.	Time of Harvesting.	Kind of Soil.	Weight of Beet Pounds......	 Ounces......	Per ct. of Total Solids	Per cent of Sucrose	Purity........
May 10, 1892.	Nov. 3, 1892.	Sandy loam, gravel and clay	....	13 3-16	17.60	17·50	99·42
do	do	do do	1	2 5-16	18.20	16.30	89.55
do	do	do do	1	7 3-16	18.60	17.80	95.70
do	do	do do	....	11 15-16	18.20	17.60	96.94
May 13, 1892.	do	do do	....	14 7-16	23.40	20.20	86.33
do	do	do do	....	14 9-16	24.60	21.60	87.82
do	do	do do	....	11¼	24.20	21.00	86.77
do	do	do do	....	15 15-16	19.20	17.80	94.86
do	do	do do	....	13 7-16	18.80	17.20	93.97
do	do	do do	....	11 3-16	18.30	17.20	93.97
May 11, 1892.	do	do do	....	13⅜	20.00	18.00	95.43
do	do	do do	....	10⅛	18.80	14.40	76.60
do	do	do do	....	11¼	18.80	14.40	76.60
May 13, 1892.	do	do do	1	5 14-16	17.00	16.80	98.83
do	do	do do	....	12 15-16	19.80	17.50	88.36
do	do	do do	....	8 13-16	18.60	17.60	94.62
do	do	do do	....	13 7-16	18.60	17.60	94.62
do	do	do do	....	9¾	18.20	14.30	78.56
do	do	do do	....	8⅞	18.20	14.30	78.56
May 10, 1892.		do do	4	8½	17.20	15.10	87.80
do		do do	5	2	15.00	11.00	73.31
May 11, 1892.		do do	2	10	15.60	13.40	85.90
May 10, 1892.	Nov. 2, 1892.	Sand and Silt	3	8½	15.20	11.80	77.74
do	do	do.	2	13½	14.60	11.80	80.81
do	do	do.	2	6	16.20	13.40	82.71
do	do	do.	1	6½	14.80	11.30	76.34
do	do	do.	1	8	18.20	14.10	77 46
do	do	do.	1	4 15-16	16.40	13.70	83.54
do	do	do.	....	13 9-16	18.20	15.50	85.25
do	do	do.	....	12 1-16	18.20	14.40	79.12
do	do	do.	....	11¼	18.20	14.50	79.67
Mch 28, 1892	Nov. 11, 1892	Sandy loam, gravel and clay.	1	8½	19.40	16.20	83.50
do	do	do do	....	7½	19.60	16.70	85.20
do	do	do do.	....	5¾	19.60	16.70	85.20
do	do	do do	2	8	17.60	14.70	83.52
do	do	do do	1	3½	18.20	16.50	92.76
do	do	do do	....	5½	19.40	17.10	88.14
Mch 30, 1892	Nov. 10, 1892	do do.	....	8	19.70	17.50	88.81
do	do	do do	....	15½	20.10	18.20	90.55
do	do	do do	2	4	18.60	16.00	86.02
		do do	3	8½	15.20	12.50	82.24
		do do	..	7½	20.00	18.10	86.43
		do do	1	13	18.20	15.30	84.06
		do do	1	9	19.00	15.70	82.62
June 19, 1892		Mixed Soil	1	10¼	14.00	11.90	85.00
do		do.	1	13 1-16	15.40	13.20	85.68

NO. 5.—SHOWING ANALYSES OF

Station number...	Grower.	Postoffice Address.	Seed from	Variety of Beets.
479	**Henry Fish**	Eureka, Eureka Co.	Grand Island, Neb.	Desprez
480	do...do	do...do...do	do...do	do
481	do...do	do...do...do	do...do	do
482	do...do	do...do...do	do...do	do
483	do...do	do...do...do	do...do	do
484	do...do	do...do...do	do...do	do
485	do...do	do...do...do	do...do	do
486	do...do	do...do...do	do...do	do
487	do...do	do...do...do	do...do	do
488	do...do	do...do...do	do...do	do
489	do...do	do...do...do	do...do	do
490	do...do	do...do...do	do...do	do
491	**C. R. Flannagan**	Wells, Elko County		Verb. Kleinwanzlebener
492	do...do	do...do...do		do...do
493	do...do	do...do...do		do...do
494	**J. Symon**			
495	do...do			
496	do...do			
497	do...do			
498	do...do			
499	do...do			
500	**Chris Rabe**	Sheridan, Douglas Co.	Chino, California	Vilmorin Amelioree
501	do...do	do...do...do	do...do	do...do
502	do...do	do...do...do	do...do	do...do
503	do...do	do...do...do	do...do	do...do
504	do...do	do...do...do	do...do	do...do
505	do...do	do...do...do	do...do	do...do
506	**John Harrison**	Lovelocks	do...do	Common Mangle Wortzel
507				
508				
509				
510	**J. Yount**	Pakramp Valley	Chino, California	
511	do...do	do...do...do	do...do	
512	do...do	do...do...do	do...do	
513				
514				
515				
516	**C. L. Deady**	Belmont, Nye Co	Watsonville, Cala.	Verb. Kleinwanzlebene
517	do...do	do...do...do		Improved Vilmorin
518	do...do	do...do...do		do...do
519	do...do	do...do...do	Chino, California	Florimond Desprez
520	do...do	do...do...do	do...do	do...do
521	do...do	do...do...do	Watsonville, Cala.	Verb. Kleinwanzlebene

EXPLANATION OF

By "total solids" is meant the entire amount of solid matter (sugar and other substances) in 100 pa
the amount of crystalizable sugar in 100 parts of the juice. By purity is meant the amount of sucrose in t
cent sucrose, purity 83.83 per cent. This means that in every 100 pounds of the beet juice there are 20.
are 83.83 pounds of sugar, or that the juice has a purity of 83.83 per cent.

Cultivation, as reported by farmers, will average with a horse three times, hoed once, irrigations thi

ETS FOR SEASON OF 1892.—*Concluded.*

Time of Planting.	Time of Harvesting.	Kind of Soil.	Weight of Beet		Per ct. of Total Solids	Per cent of Sucrose	Purity
			Pounds	Ounces			
June 19, 1892		Mixed Soil	1	5 3-16	16.40	14.30	87.20
do		do.	1	10⅞	18.40	15.00	81.52
June 21, 189	Oct. 10, 1892.	Non Clay	1	9 11-16	16.40	13.60	82.92
do	do	do.	1	8⅜	16.10	14.30	89.37
do	do	do.	1	13 5-16	14.00	12.10	86.43
do	do	do.	1	15⅜	15.60	13.50	86.53
June 20, 1892	Oct. 1, 1892.	Mixed Soil	1	13 5-16	14.20	12.05	84.85
do	do	do.	2	14 15-16	13.60	11.50	84 56
do	do	do.	1	14¾	13.50	11.35	84.08
do	do	do.	1	⅞	15.10	13.60	90.05
do	do	do.	1	5 7-16	14.20	12.10	85.21
do	do	do.	1	4 7-16	15.15	13.00	85.80
June 6, 1892.	Oct. 7, 1892.		1	7 7-16	19.00	16.60	87.35
do	do		1	2 5-16	20.00	18.30	91.51
do	do		1	1 3-16	20.60	18.50	89.80
			1	7⅜	21.00	18.90	90.01
			1	13-16	20.30	17 95	88.42
			1	14 3-16	19.00	16.55	87.10
			1	1 3-16	18.50	16.40	88.63
			1	15-16	21.50	19.00	88.38
				10 9-16	20.20	18.50	91.57
June 10, 1892	Oct. 20, 1892.	Loam	1	8⅝	15.40	13.10	85.07
do	do	do.	1	3 9-16	16.20	14.20	87.65
do	do	do.	1	2¾	16.40	14.60	89.04
do	do	do.	1	15¼	16.10	14.00	86.95
do	do	do.		7 7-16	15.20	13.10	86.20
do	do	do.		3⅜	15.50	13.20	85.27
			2	10	17.00	3.50	48 56
			1	10	17.50	15.20	88 87
				10¼	17 20	14.50	84.32
				13	17.60	14.80	84.10
				13⅞	18.20	15.60	85.70
				10⅜	16.40	13.80	84.15
			1	3-16	19.50	17.60	90.26
			9	1 15-16	17.30	14.15	81.80
				9¼	18 50	16.30	88.10
				7 7-16	19.30	17.00	88.06
				7½	15.30	13.40	86.28
				10¾	16.20	14.00	86.42
			2	3¼	16.80	14.40	85.18
				6¾	13.40	11.00	82.08
				13½	17.10	14.90	87.13
				5½	16.50	14.30	86.66

RMS USED IN TABLES.

of the juice; in other words, the residue left on evaporation of water from the juice. By sucrose is meant
entire solid matter of the juice; to illustrate: Beet No. 379 analyzed 20.40 per cent total solids, 17.10 per
pounds of solid matter and 17.10 pounds of sugar; also that in every 100 pounds of the solid matter there

The cultivation at the Station Farm was five times with a horse, hoed three times, irrigations ten.

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POTATOES. TOBACCO.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 20.

Reno, Nevada, March, 1893.

Agricultural Experiment Station.

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This Station is prepared to analyze and test fertilizers, soils, muck and gypsum, which may be of agricultural value, cattle foods, water, milk and dairy products, seeds, with reference to their germinating power and purity; to identify grasses and weeds and study forage plants; to investigate the diseases of fruit and fruit trees, grains and other useful plants; to make reports on injurious insects and the most practical means of combatting them.

THIS WORK IS DONE GRATIS FOR RESIDENTS OF THE STATE.

The Bulletins and Reports will be sent free to any farmer or other person interested in agriculture within the State.

Address all communications to

Agricultural Experiment Station.
Reno, Washoe County, Nevada.

Please acknowledge receipt of this Bulletin.

NEVADA WEEDS.

I.

F. H. HILLMAN.

INTRODUCTION.

The present bulletin is the first of a proposed series which will treat of the more noxious plants of Nevada. The author aims to enable the reader to recognize the various plants discussed, also their seeds or fruits. Indeed the practicability of the series is dependant upon such recognition. Doubtless the majority of readers can recognize these plants when seen in the field, but it is probably equally true that very few can recognize the seeds of these same plants. Prevention is better than remedy in dealing with most weeds, hence the power to distinguish between desirable and undesirable seed becomes necessary. To enable one to do even more than this and recognize as far as possible from these seeds, the particular plants to which they belong is one of the objects of this series of bulletins.

No new and infallible method for the isolation of seeds can be given, The use of graduated seives and fans probably will be found most efficient. In practice, the means at hand will best determine the method to be followed.

The order of treatment of the different species will be dependent upon the facilities for illustration at hand at the time of preparation of the subject matter. This, however, will prevent the consecutive arrangement of allied species which would be most desirable.

Objective illustrations will be given when circumstances will permit.

The descriptions of the various plants and their seeds will be couched in popular language as far as possible and will embody only the most salient characters. F. H. H.

SEED.

NAME.	Amount of Seed.	No. of Hills Planted....	No. of Hills Germinated	Yield.	
				Lbs.	Oz
White Flower	1 eye	43	16	22	4
White Flower	2 eyes	43	26	46	..
White Flower	½ potato	43	40	62	5
Queen of the Valley	1 eye	43	16	20	5
Queen of the Valley	2 eyes	43	27	39	8
Queen of the Valley	½ potato	43	43	58	..
Early Sunrise	Seed end	90	82	177	10
Early Sunrise	2 eyes	90	58	116	6
Early Sunrise	½ potato	90	67	145	10
Early Sunrise	Whole potato	90	84	190	15
Fearnaught	Seed end	90	87	154	10
Fearnaught	2 eyes	90	73	118	5
Fearnaught	½ potato	90	86	161	10
Fearnaught	Whole potato	90	87	220	13
White Star	1 eye	90	65	81	5
White Star	2 eyes	270	218	113	2
Morning Star	2 eyes	360	279	126	6
Early Rose	1 eye	90	42	59	5

PLANTING AT DIFFERENT DATES.

NAME.	Date Planted.	No. of Hills Planted....	No. of Hills Germinated.	Yield.	
				Lbs.	Oz
Early Sunrise	May 20	30	26	46	13
Early Sunrise	May 30	30	23	36	..
Early Sunrise	June 15	30	12	22	..
Early Sunrise	July 1	30	11	13	..
Early Sunrise	July 11	30	21	12	..
Early Rose	May 20	30	23	45	..
Early Rose	May 30	30	19	31	..
Early Rose	June 15	30	7	6	8
Early Rose	July 1	30	11	24	8
Early Rose	July 11	30	21	9	..
Brownell's Best	May 20	29	18	25	..
Brownell's Best	May 30	29	22	15	..
Brownell's Best	June 15	29	5	4	4
Brownell's Best	July 1	29	17	11	8
Brownell's Best	July 11	29	6	3	..

PLANTING OF DECEMBER 15, 1891.

NAME.	No of Hills Planted	No. of Hills Germinated.	Weight of Seed —Lbs.	Yield.	
				Lbs.	Oz
Morning Star	77	71	14	204	13
Fearnaught	85	60	14	91	5
White Flower	85	64	14	84	5
Rough Diamond	79	61	12	60	8

COVERING.

NAME.	No. of Hills Planted....	No. of Hills Germinated.	Depth.
Rough Diamond	25	23	Five inches......
Rough Diamond	25	25	{Straw covered {Twelve inches.
Rough Diamond	25	22	Six inches.......
Rough Diamond	25	24	Eight inches.....

IRRIGATION AND CULTIVATION.

The plats were irrigated seven times during the season, using water as much as possible late in the afternoon and evening.

The cultivation with an Iron Age cultivator and single shovel, with some additional work with a hoe, kept the ground practically free from weeds, and sufficiently loose to allow steady growth.

GRADING.

The grading of all varieties was on the same basis as was used in 1891. Of potatoes classed as small, an average sample measured 2½x1¾ inches and weighed 2½ ounces. Owing to varying amounts of seed on hand and somewhat limited area, the different varieties could not be planted in large. or an equal number of hills.

Considerable benefit was derived from the use of Bordeaux mixture in preventing blight.

VARIETY.	No of Hills Planted	No. of Hills Germinated.	Yield.			
			Small.		Total.	
			Lbs	Oz	Lbs.	Oz
Stray Beauty	33	27	3	..	24	..
Dictator	66	20	Non	e	62	5
Summit	66	58	23	..	113	4
White Star	66	63	15	13	146	2
Queen of the Valley	43	40	14	5	117	7
Mullally	33	29	6	5	61	2
Green Mountain	66	65	22	13	155	12
Early Mayflower	66	54	6	13	72	15
Crane's Extra Keeper	66	65	5	5	119	15
Northern Spy	33	31	Non	e	57	4
Early Market	66	62	8	5	75	11
Early Rose	66	59	30	5	107	10
Rough Diamond	66	58	16	13	105	7
Early Sunrise	66	61	9	5	117	14
Morning Star	66	64	5	5	132	..
Fearnaught	66	63	9	5	122	7
Vanguard	66	58	....	..	81	8
Triumph	66	50	19	5	62	2
Early Ohio	66	66	2	13	121	11
St. Patrick	66	66	28	5	150	2
Beauty of Hebron	66	64	4	..	95	15
Pearl of Savoy	66	63	15	..	133	3
Governor Foraker	66	56	13	5	110	8
Princess	66	59	4	13	71	2
Monroe Co. Prize	66	57	15	13	110	15
Howe's Premium	33	25	....	..	21	..
Minister	33	31	8	12	40	1
Bill Nye	66	66	10	..	131	8
Polaris	66	54	8	5	57	6
Vick's Perfection	66	57	11	5	98	7
Roanoke	33	26	4	5	54	10
Nott's Victor	33	27	4	13	30	6
White Flower	43	43	6	5	136	2
Six Weeks	33	33	3	5	25	15
Champion	....	....	8	5	84	9
Thorburn	66	57	....	..	82	..
Winner	66	59	9	5	129	11
Charles Dowing	66	64	10	..	92	13
Jumbo	33	27	2	5	44	12
White Elephant	66	64	7	5	157	..
Snow Flake	66	61	4	13	104	12
Empire State	66	59	14	5	145	..
Pride of the West	33	31	4	13	68	6
Delaware	33	33	1	9	64	1
Clark's No. 1	66	54	4	5	66	8
Early Marine	66	64	6	..	127	2
Brownell's Best	66	55	....	..	47	3
Early Durham	33	20	4	9	34	2

VARIETY	No. of Hills Planted	No. of Hills Germinated......	Yield.			
			Small.		Total.	
			Lbs.	Oz	Lbs.	Oz
Finch's Perfection	66	63	13	5	119	11
Centennial	33	30	3	13	54	2
Potentate	3	27	Non	e	35	15
Blue Victor	39	33	1	8	32	8
Elephant	64	43	8	..	66	5
Farina	24	10	1	8	13	..
Compton's Surprise	44	27	3	8	23	..
Hoag's Seedling	44	38	4	..	32	5
Perfect Peachblow	46	23	3	8	14	4
Pride of Japan	42	33	2	8	38	5
Pearl Prolific	40	33	3	8	36	13
Seedling No. 37	39	34	5	8	33	8
Peoples	10	5	....	..	4	..
Grange	60	52	8	..	74	8
White Victor	29	26	1	8	34	..
Late Ohio	54	47	4	..	44	..
Seedling No. 15	35	34	3	8	45	13
Rose Seedling	50	35	1	8	33	..

The following list of questions was mailed to farmers who have made a specialty of growing potatoes in quantity. To date only three have sent answers:

QUESTIONS.

1. What time of the year do you plow land for potatoes?
2. How deep do you plow?
3. Do you use a land roller?
4. What kind of harrow is used?
5. What size are potatoes that you plant?
6. Into how many pieces do you cut potatoes for planting?
7. How far apart do you place the rows?
8. Do you plant a single piece of seed to each hill?
9. Distance between hills?
10. How deep do you plant?
11. How do you cover seed?
12. What style and make of cultivator do you use?
13. How often do you irrigate; total number for season?
14. How do you dig the crop.

15. As a general rule at what time of the year do you get the best prices for potatoes?

16. What market do you prefer?

17. What kinds of potatoes do you prefer for cooking or market?

18. What kind of soil gives best results?

19. Why do you prefer potato raising for a special crop?

20. How many tons of potatoes did you raise in 1891 and 1892?

21. What rotation of crops do you use.

22. What has been the range in prices for 10 years?

W. C. PITT. LOVELOCK.

1. Early spring.

2. About four inches.

3. No.

4. Ordinary iron harrow, or a float made of boards.

5. Medium and small.

6. Two eyes to a piece.

7. Thirty-two inches.

8. Yes.

9. Twelve inches.

10. About four inches.

11. Previous to 1893 with a plow, but this season I have used a potato planter and find it a success.

12. Shovel plow. Plow about three times.

13. Three times. Usually depends on the lay of the land.

14. Usually plow them out, but find a potato digger worked by horses the best.

15. In the early spring is the best prices but the shrinkage and waste to keep them over will more than make the difference in price.

16. The home or local market is the best, but we depend on the California market.

17. For cooking and keeping the Centennials are the best; for California market Burbanks are best.

18. Black loom or tule bog well rotted, mixed with a little sand.

19. It will yield more returns for labor and money invested.

20. In 1892, 120 tons.

21. I have raised them on new land altogether, and find the second and third years the best.

22. The last three years the price has been about $15 per ton. Previous to that the price ranged some higher, but there only being a limited amount raised the crop was usually disposed of in the local market, but late years more have been raised and we have had to take California market, our potatoes commanding the very highest prices there.

JOHN HILL, LOVELOCK.

1. Fall.
2. Eight or nine inches.
3. No.
4. Common four-horse harrow.
5. Medium.
6. From one to two eyes.
7. Two feet, ten inches.
8. Yes.
9. Sixteen inches.
10. Four and one-half to five inches.
11. With twelve-inch plow.
12. None.
13. That depends on nature of soil.
14. With twelve-inch plow.
15. In early spring.
16. California market.
17. Burbank.
18. Sandy loam.
19. It pays better.
20. Didn't plant in 1891; in 1892, 350 tons.
21. Sow wheat after potatoes.
22. For eight years average price $18 per ton.

GEORGE ALT, GLENDALE.

1. April.
2. Eight inches.
3. No, a float.
4. Common iron harrow.
5. Small ones.

6. From two to eight pieces.
7. Thirty inches.
8. Yes.
9. Fifteen inches.
10. Three and one-half inches.
11. With a plow.
12. Planet, Jr.
13. Every ten days; about five times.
14. Potato fork.
15. May.
16. San Francisco.
17. Burbank Seedling.
18. Sandy clay loam.
19. I do not.
20. Two hundred tons.
21. Potatoes, onions, cabbage, carrots.
22. From $10 to $60 per ton.

With a trial of only one season and in small area but little can be said for the December 15th planting. The potatoes made a good growth during the season and were in good condition when harvested. If the crop is a certainty, or as much so as planting at the usual time, it would make a less rush of farm work in the spring by planting a portion of the crop in the winter season.

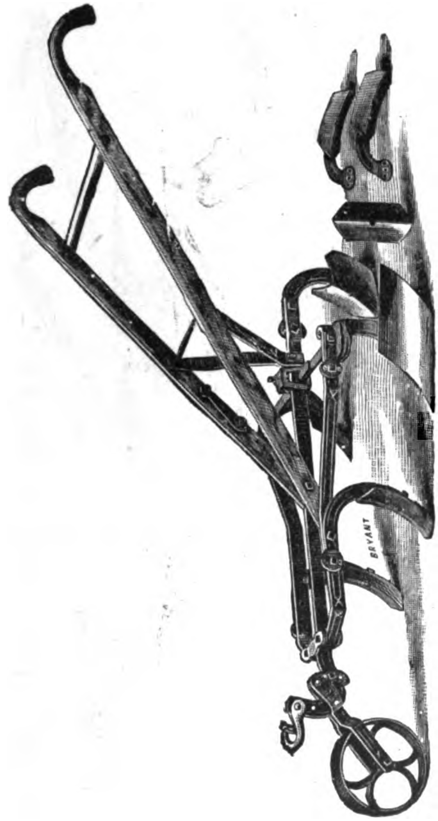
CUTS OF IMPLEMENTS.

No. 1 shows a good all-a-round cultivator, adjustable to different widths of row, and varying the amount of soil moved by changing shovels.

Two kinds of diggers are shown in No. 2, manufactured by the Moline Co. of Illinois.

Nos. 3 and 4 show different styles of diggers handled by Baker & Hamilton of Sacramento.

To the above named firms the Station is indebted for the use of electros. The Station has not used any of the diggers represented. Farmers are fully aware of the desirability of using as much horse labor as possible, either in cultivation or harvesting.



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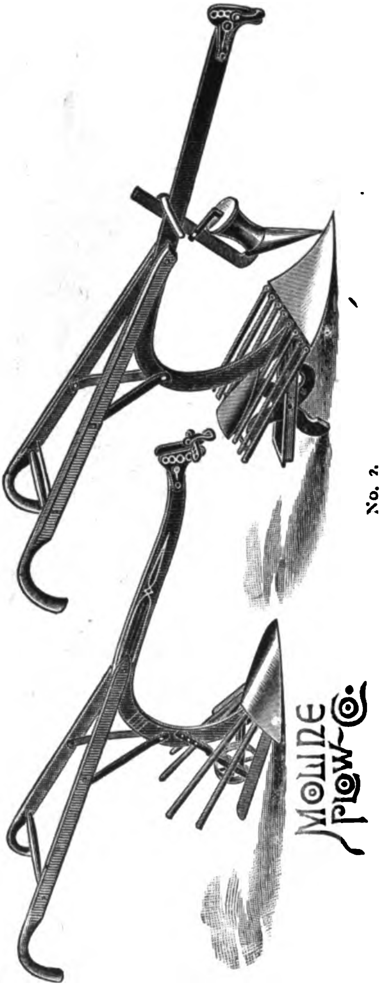
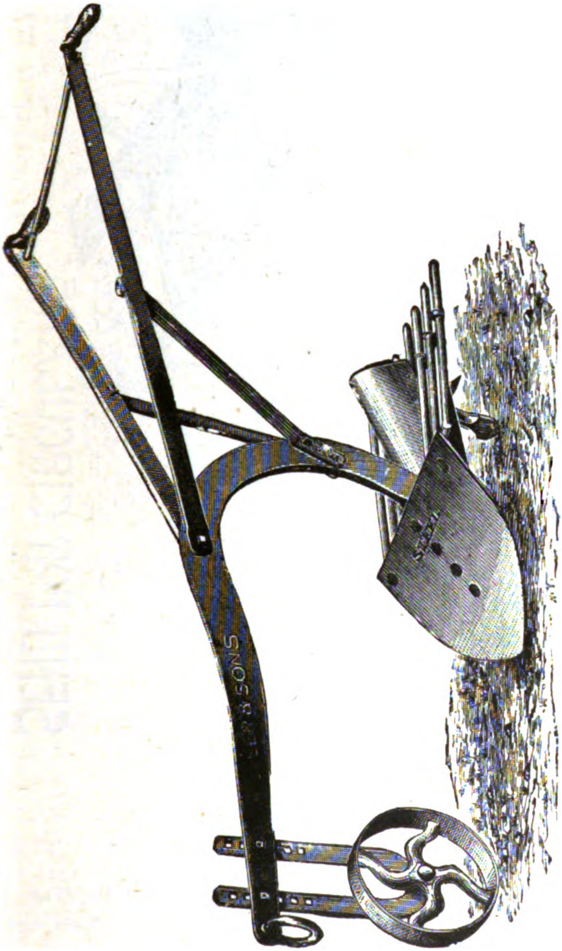

Moline Plow Co.

No. 2.



No. 3

PRUYN THE RELIABLE

SEND FOR CIRCULARS
PRUYN POTATO DIGGER CO HOOSICK FALLS, N.Y.

No. 4.

STARCH FACTORY.

Some attention has been given by several of our citizens in the direction of a factory for the manufacture of starch from potatoes, taking the potatoes direct from the field to the factory. The machinery is comparatively inexpensive and the process of manufacture rather simple. One of these plants, if put in operation, would afford another market for a portion, at least, of our potatoes, using both large and small, and turning out a more concentrated article for freight traffic.

TOBACCO.

The following notes on tobacco culture, so far as taken at this Station, are merely a report of progress. We are not, nor are the farmers of any locality, so far as heard from, making a specialty of tobacco growing. In connection with other experiments a small area was first set out in 1891. In the spring of 1892 one-fourth of an acre was planted on June 14th with the varieties named in the table. The seed was sown in a hot-bed February 24th.

The several varieties were grown with a view to determine which would best meet the wants of this State; the quality and quantity of field growth that could be obtained, and to secure all data possible on curing in a section of country that in climate and farm practice is in strong contrast with the chief tobacco growing centers.

SEED.

This seed can be obtained of any reliable seedsman and should, for this section of the State, be sown in a hot-bed early in March and transplanted to open ground at the earliest opportunity to allow of ripening in advance of frosts.

Practical directions for making a hot-bed at moderate cost can be found in the seed catalogue of D. M. Ferry of Detroit, Michigan. The farmer need not necessarily go to the expense of sash and glass. A heavy quality of muslin well tacked to a frame, with a covering of grain sacks and a few boards, in case the weather becomes cold after the bed is sown, will answer every purpose.

Avoid thick seeding in the bed, or thin out the plants and harden off by giving plenty of air and sun before transplanting.

IRRIGATION.

Should the ground be very dry at the time of transplanting, a light furrow of water may be run along the line to be occupied by the plants, and near to this a second furrow to continue the irrigation till the plants are well established, or for the season. The practice at the Station has been to irrigate about once in ten days, using the same amount of water as given other crops. To date no trials of varying the number of irrigations have been made with tobacco.

Colorado Bulletin No. 4 says: "The tobacco plant, while a great feeder, is very impatient of too much moisture in the soil. We irrigated but twice, and believe that once would have been sufficient. Rich land, with sufficient and timely cultivation, will go far toward maturing a crop of this plant in this State. In fact, if irrigated much, it will not ripen. No crop is so effectually destroyed on wet lands as tobacco, and none is so little affected by drouth."

It is doubtless true that in many instances in the arid region too much water is used for irrigation. The altitude of the Colorado Station, where the notes were taken for Bulletin No. 4, is 5,000 feet, and the rainfall for April and May is frequently four inches or more.

TABLE OF VARIETIES.

NAME.	No. of Rows....	Weight.		Length of Leaf —Inches......	Width of Leaf— Inches......	Height of Plant —Inches......
		Lbs.	Oz			
Conn. Seed Leaf	4	155	8	21	10	37
Ky. White Stem	2	51	..	23	10	35
Yellow Burley	6	149	8	22	8	34
New Primus	3	87	8	23	13	44
Hester	4	136	..	24	14	44
Havana	2	71	8	20	10	42
Big Havana	4	125	..	19	10	38
Sterling	2	51	8	23	12	39
Sweet Oronoko	3	93	..	23	11	38
Big Oronoko	3	96	8	22	12	40
Primus (Cox)	3	109	8	24	12	40
White Burley	2	47	.	22	9	30

TABLE.

The weights of tobacco as given in the table were taken the day following the harvesting, which was September 26th. Each row was four rods in length, with two feet between plants, and two and one-half feet between the rows. On some soils, with large growing varieties, it might be best to give more space to each plant. The notes on length of leaf were taken on September 6th. Duplicates of certain varieties mentioned in the table were grown in sufficient number of rows to make one-fourth of an acre.

INSECTS.

The "horn worm" is the worst pest we have, but has been held in check by daily picking. The plan of poisoning the moth, as outlined in the Georgia Bulletin, is, without doubt, a paying preventive.

For profit, in Alabama, tobacco is ranked as a leading crop. From the testimony in regard to the Station-grown tobacco, of some people who are competent to judge of its smoking qualities, it is a fair presumption that with systematic effort a good commercial article can be grown and cured in this State, especially in favored localities and by those who have a liking for this branch of farming.

CURING.

While we are progressing with the important item of curing, as yet perfection has not been reached. Our efforts have been largely along the same line as mapped out by Alabama, Georgia and Colorado. Better results are being attained with increased experience, even with apparatus for curing that is not claimed to be the latest. In trying the suggestion of Georgia for "curing the leaf—120 to 125 degrees, six to eight hours," with our stove only 118 degrees could be reached.

As requests have been sent in by farmers for methods in curing, it is thought best to give extracts from southern Bulletins whose notes were taken in the natural home of the tobacco plant.

The following extracts on tobacco culture and curing are taken from a Bulletin issued by the Alabama Station:

CLIMATIC CONDITIONS.

"Of the many conditions which affect the quality of tobacco, the most important is climate; other conditions may be, in a measure, modified, but very little can be done with regard to climate. The most rational mode of overcoming this difficulty would be in the selection of seed of the varieties which have been grown with success under similar climatic conditions as prevail in the district proposed to be cultivated.

"In this State, with its range of climate from semi-tropical to temperate, a wide margin is permitted to the grower, and seed can be procured suitable to all parts of the State. In tobacco, as in all other crops, the aim of the grower should be to produce the kind which will command the highest price. The most valuable tobaccos are the Cuban and Manilla, and they owe their fame mostly to the favorable conditions under which they are grown. These places possess a tropical heat, but at the same time are tempered with the sea breeze, and there are, no doubt, parts of the coastal districts of this State which may produce an article that could compare with these tobaccos.

"Tobacco thrives best in a good rich soil, rich in vegetable mould, but light soil containing a good amount of organic matter and well drained will produce an excellent smoking tobacco, and on such soil the finest leaves are grown. The more clay in the soil the thicker the leaves become, and the aroma becomes less, and is consequently less suited for the finer qualities of smoking tobacco, although the weight of yield may be heavier.

"Black prairie land will probably yield more to the acre than any other kind of land in this State, but the tobacco will not possess so fine a quality. On such soil it grows larger, has coarser stems and a heavier leaf, and is not so good for wrappers, or fine cut or cigarettes and cigars as the upland tobacco on sandy soils. Though tobacco is a hardy plant and will grow under varied conditions, yet to become a profitable crop it must not be grown in a situation very different from that to which it is suited by nature. It must be remembered that the plant is a native of a warm climate, and thrives best in a moist atmosphere; therefore, in such a climate, by employing ordinary means, tobacco may be made to yield a profit not attainable in less favored situations. A warm, moist climate will permit of the selection of the varieties that sell at the highest price in the market, and in a suitable soil the profit will be such as is not often or easily realized from any other crop.

"From a table at hand, which gives the essential features of the crops of cotton for the year 1888, in the United States, it appears that the yield per acre for cotton was one hundred and eighty pounds; price per pound, eight and a half cents; value per acre, $15.30.

"With tobacco the average annual production during the past decade has been about one-sixth that of cotton. The average yield per acre has been about seven hundred and twenty-five pounds, with an average of eight and one-half cents per pound, making the value of tobacco per acre $61.62½.

"As the Havana tobaccos command the highest price, growers everywhere attempt to introduce and cultivate them. The difficulty in growing these varieties is they speedily degenerate if the conditions are not favorable. Virginia tobacco is the most favored in temperate climates, as it does not require such a high temperature, but on account of its botanical characteristics it is not much liked by cigar or cut tobacco manufacturers. A high price is generally commanded, no matter of what variety, which possesses either a light mahogany, cinnamon, or golden color, and fine aroma, with thin ribs far apart and even. The wider the leaf and the less they are worm eaten or torn the greater the number of wrappers which can be cut from a pound for making cigars, consequently manufacturers will pay more for grades possessing these qualities than for others. There are among growers as many varieties of tobacco as there are varieties of cabbage, each section favoring a particular kind.

"It mav, however, be said of the varieties most generally grown in America, that the Kentucky, Virginia and Maryland are employed for chewing, pipe and cigarette smoking, while the Connecticut seed leaf and Havana are most in use for fillers and wrappers in the manufacture of cigars.

"Tobacco is now cultivated through a wider range of temperature than any other tropical plant, and whether grown amid the plains of South America or in the rich valleys of Southside Virginia, or as far north as Connecticut, develop its finest form and perfection of leaf.

"During the last half century the plant has been developed to a greater extent than during the three hundred years succeeding its discovery. Its cultivation and management have been reduced to an approach to an exact science, and the quality of the leaf is, in a great measure, within the control of the growers of the plant. Until quite recently it was supposed that the varieties that grew in the tropics could not be cultivated with success in the temperate regions, but recent experiments have demonstrated the fact that the tobacco of Cuba can be grown with success in many parts of the United States. The tobacco raised in the tropics is the finest in flavor, while the more temperate regions produce the finest and best colored leaf.

"The tobacco of the tropics, as to the uses to which it is put, is limited, while the tobacco of the more temperate regions can be used for all the purposes for which the plant is needed.

"Formerly but little attention was paid to the color and texture of the leaf, the principal object being the production of a leaf of large size, rather than one of good color and of silky texture. Now these are most important conditions, and give value to the tobacco in proportion to the perfection of these qualities."

FIELD CULTURE.

"Land on which it is intended to grow tobacco should be well plowed. On compact soils the plowing should be deep. An intelligent rotation of crops carried out with an intelligent knowledge of the needs of the tobacco crop will be the aim of the practical farmer. Before transplanting the young plants from the seed-bed the land should be ridged, the distance between the ridges depending on the kind of tobacco to be planted—the larger kinds requiring more room than the smaller-leaved and tall sorts; but they should be far enough apart to allow a free passage between the rows of plants without injuring the plants. Generally from three to three and a half feet apart between the rows, and the same between the plants will be sufficient. Where the surface is level the plow may be run lightly over the field at right angles, thus forming small hills on which the plants are planted."

"Generally the plant obtains its finest form and quality of leaf on lands bordering the largest rivers. This is true of the tobacco lands of Connecticut, Kentucky, Virginia and North Carolina, as well as of those in the islands of Cuba and San Domingo; but some of the finest tobacco grown in the United States is grown in countries some distance from large rivers.

"When possible, select the kind of soil for tobacco that will produce the color and texture desired. For Connecticut seed leaf a light moist loam is the best soil. For the bright tobaccos, such as are raised in Virginia, North Carolina and Maryland, the soil should be light and friable, or what is commonly called a sandy loam, not too flat, but of a rolling, undulating surface not liable to overflow in excessive rains. New cleared in these last named States is considered better than long cultivated soils. In Cuba the planters select the red soil as the best for fine tobacco. Some planters, however, prefer a soil mixed of one-fourth sand and one-half to three-fourths of decayed vegetable matter."

"The planting is similar to the planting of cabbage and is no more difficult. A good plan is for a boy to walk between the ridges, placing the plants alternately to right and left, being followed by the planters, who place the plants in the hills or ridges, taking the precaution to leave the bud well above the surface.

"In a few days any missing hills which occur should be replanted, and during the early growth a close watch must be kept for the cut worm, bore worm, and other injurious insects. When the plants have taken root they grow very quickly, and subsequent cultivation is simple, though requiring care."

THE STALK.

"The tobacco stalk varies with the varieties of the plant. All of the species cultivated in the United States have stalks of a large size, much larger than many varieties grown in the tropics. The American varieties have erect, round, hairy, viscid stalks and large fibrous roots, while the foreign varieties are harder and much smaller."

"*The Leaves.*—The plant bears from eight to twenty leaves, accordthe to the species of the plant. The color of the leaves when growing, as well as after curing and sweating, varies, and is frequently caused by the condition of the soil. The color, while growing, may be either a light or dark green, which usually changes to a yellowish cast as the plant ripens. The ground leaves generally ripen first, turning yellow, and during wet weather will rot and drop from the stalk if not gathered. The color of the leaf after curing may be determined by the color of the leaf while growing. If dark green while maturing in the field, the color will be dark after curing and sweating, and the reverse if of a lighter shade of green. If the soil be dark, the color of the leaf will be darker than if grown upon light soil. The kind of fertilizers applied to the soil, as well as the soil itself, has much to do with the texture of the leaf, and should be duly considered by all growers of the plant."

"*The Sucker.*—The sucker makes its appearance at the junction of the leaves and stalk. Usually these are not seen until after the plant has been topped, when they come forward rapidly, and if not plucked off in a short time develop into strong, vigorous shoots. The growth of the suckers is injurious to the leaf, retarding their size and maturity, and affect the quality as well as the maturity of the plant. When the plants are fully ripe and ready to harvest, the suckers will be found to be growing around the root of the plant. This is one of the most reliable evidences of its maturity, as it denotes the ripening of the entire plant. Breaking off the suckers hastens the ripening of the leaves and gives a lighter shade of color, no matter on what soil the plants are grown.

Topping.—Topping is simply breaking off the bud at the top of the stalk to prevent the plant running up to flower and seed. By this means the best growth of the leaves is secured, and they at once develop to the largest possible size ; will ripen sooner, while the quality is much better.

"There are various methods of topping, as well as different periods. Some planters top as soon as the capsules appear, while others wait until the plants are in full blossom. If topped before the plants have come into blossom, it should be done as soon as possible, as a longer time will be required for the leaves to grow and ripen than when topping is delayed until the plants are in bloom. Top the plants at a regular height, leaving from nine to twelve leaves, so that the field will look even and also make the number of leaves to a plant uniform. The above method of topping refers more especially to ciger rather than cutting leaf. Those varieties of tobacco suited for cutting leaf should be topped as soon as the flower bud appears ; top low, thereby throwing the strength of the stalk into a few leaves, making them large and heavy. Let it grow from five to six weeks after it is topped, so as to have it thoroughly ripe, thereby giving it the bright, rich, golden color, entirely different from cigar leaf but desirable for chewing leaf. The custom in the old tobacco States is to top for English shipping from eight to ten leaves ; for coal curing, from ten to twelve. In some sections of the United States the plants are not topped at all ; the leaves are left upon the stalk until they are fully ripe, when they are taken off."

VARIETIES OF TOBACCO AND HARVESTING.

"Tradition indicates that the variety of Connecticut seed leaf was introduced originally into the New England States by B. P. Barber, and it is thought to belong to the Cuban variety. The varieties cultivated in the United States and known as 'seed leaf' tobaccos are grown in Connecticut, Massachusetts, Vermont, and eastern and western States. All of the seed leaf of the United States is used exclusively in the manufacture of cigars, and is celebrated for cigar wrappers from the superiority of its color and texture, and the good burning quality of the leaf. The plant grows to the height of about five feet, with leaves from two and one-half to three feet in length, and from fifteen to twenty inches broad. The color of this tobacco after curing is either dark or light cinnamon.

"There are two principal varieties of Connecticut seed leaf—broad and narrow leaf. Of these two, the broad leaf is considered the finest, cutting up to better advantage in cigar making, and ripening and curing fully as well.

"This tobacco has not that fine flavor of Cuban tobacco, but in texture is considered equal to it. It burns freely, leaving a white or pearl colored ash, which is one of the best evidences of a good cigar tobacco. The leaf is firm and strong, and sufficiently elastic to bear considerable manipulating in manufacture. Thorough cultivation by the growers has made this quality of tobacco one of the most profitable of any tobacco grown in the United States.

"Virginia tobacco has acquired a reputation which has gradually increased for more than two hundred and fifty years. The plant grows to the height of from three to five feet; the leaves are long and broad, and when cured are of various colors, from a rich brown mahogany, cinnamon, to a fine golden yellow. The finest quality of Virginia tobacco comes from the southside counties, but the amount is small compared to the quantities of dark raised on the lowlands of the Dan and James rivers and their tributaries. The tobacco grown in the southside and southwestern counties of Virginia is much lighter in color, and of much softer and finer texture than the ordinary Virginia tobacco."

"*Havana Tobacco.*—This famous variety of tobacco is considered the finest flavored for cigars that is now cultivated. This variety, it is stated, grows to a height of from six to nine feet, with oblong, spear-shaped leaves. The leaves, when young, are of a dark green color, and have rather a smooth appearance, changing at maturity into yellowish green. This variety grows quickly, and by careful pruning a fine colored leaf is obtained, varying from a straw color to a dark brown or black.

"The finest is grown in Vuelta de Abajo, which for nearly a century has been celebrated as a fine tobacco-producing district. The Havana tobacco ripens in from eight to ten weeks after being transplanted. The stalk and leaves are not as large as the Connecticut seed leaf, but it is better in flavor."

"*Cutting the Plant.*—There are two methods of harvesting—cutting down the whole plant or gathering the leaves singly. The former is the one that has been practiced for a long time by tobacco planters; the latter, which is of recent origin, is regarded by many as the most scientific method. Both these plans of gathering have their advantages. The first is the easiest and permits of quicker handling, but the leaves have to be assorted afterwards, while the latter permits the sorting of the leaves in the first operation, and the development of a greater number of mature leaves.

"For cutting, a heavy knife is used, and the method is similar to cutting sugar cane, the plant being held with the left hand and cut close to the ground. The plants should be removed to a shady place to prevent their becoming sunburnt.

"After the plant is wilted and becomes pliant and in good condition to handle without breaking, it should be placed on the stick. Some tobacco growers hold the opinion that the plants should be harvested without wilting at all, stringing on the stick as soon as cut, and carrying them immediately to the tobacco barn. The reason for this is that often at the time of cutting the plant the ground is hot, and the plant becomes very warm and quickly sunburned. When hung on the stick, which is four and a half feet in length, six to eight large plants are he usual number."

"The process of curing now commences, and on the success of this operation depends in a great measure the ultimate value of the crop. No matter how fine the plants may be, or how large the production, an error in curing is sufficient to destroy, in a great degree, the work of the season. The tobacco barn should be built with windows and doors sufficient to insure a free current of air. The barn should be high enough to permit three rows of plants being hung one above the other, say sixteen to eighteen feet from floor to roof.

"There are several methods of curing, viz.: Air curing, sun curing, curing with open fires, and curing by flues. Air curing is the process of curing the plant in shade or barn. Sun curing is the method of curing in the open air, while firing is the process of curing as above stated, either by open fires or flues in the tobacco barn. The latter method is the one generally practiced in the tobacco sections in Virginia, North Carolina, and to some extent in the west, and is considered the best way of curing cutting leaf."

"*Method of Curing.*—There are two common methods practiced of handling tobacco for curing—the older and long favored method of cutting and hanging the whole stalk with the leaves attached, and the method of detaching the leaves from the stalk before hanging, a method which is comparatively new in this country, but is employed to considerable extent in Germany and France. These methods are too long to be discussed fully in this Bulletin for the purpose of passing on the merits of either.

"A recent experiment conducted at the North Carolina Experiment Station, with a view of settling the matter, indicates that a comparison between the weight of one-half a crop of tobacco cured on the stalk and the other half cured separate from the stalk shows a difference of weight of one hundred and twenty-eight pounds per half acre in favor of the latter. Major R. L. Ragland, a large and successful grower of tobacco in Virginia, states that he has for years employed both methods with success, and there is no doubt that in parts of Virginia and North Caralina the method of stripping the leaves has recently come into decided favor."

SNOW'S MODERN TOBACCO BARN.

"This new process of harvesting and curing tobacco was introduced by W. H. Snow of Highpoint, North Carolina. It is not necessary at present to give details for the construction of this barn and apparatus. It is claimed that this system of curing tobacco in the Snow modern barn has important advantages. The leaves are stripped from the stalks in the field and brought to the barn in baskets, and strung about the width of a finger apart on pointed wires which project at right angles from a wooden stick. As the sticks are filled they are placed in movable racks in the barn, and as fast as a rack is filled it is raised by a simple device to the top of the building. This is continued until the barn is filled, leaving only as much space between racks as is required for the hanging leaves."

"*Advantages of the Method.*—The following are some of the important advantages claimed for the Snow process over the old :

"I. The planter can begin to house his crop from two to four weeks earlier, as the bottom leaves, which ripen first, can be taken off and cured as soon as they are ripe.

"II.—As the lower leaves are pulled off those left on the stalk ripen up more rapidly, which enables the planter to get in his crop earlier in the season.

"III.—The tobacco can be stored in a much smaller space and with no risk of losing color or molding when bulked down.

"IV.—Tobacco can be cured with a more uniform color.

"V.—Less fuel will be required, and the risk of setting fire to the barn will be greatly lessened."

"*Flues and Flue Curing.*—Flues have almost entirely superseded open fires for curing yellow tobacco as being cheaper and better every way. The heat is more readily controlled by the use of flues, and the tobacco cured by this process is cleaner, brighter and sweeter. The flue is regarded as the best mode for applying heat in the curing process for any type of tobacco requiring the application of artifical heat, and is fast superseding the open wood fire."

"After the tobacco is thoroughly cured it has to be stripped. The leaves become soft and pliant in damp weather and can be readily taken down out of the barn for stripping. After taking down, the plants should be packed, in order to be kept moist until stripping.

"This operation consists in taking the leaves from the stalk and tying them in bundles after assorting the various qualities and keeping them separate. Each hand or bundle of the best grades should contain at least twelve leaves. In the old tobacco States the plant is usually made into three grades—long, short and lugs, or worm eaten leaves.

"In Cuba the leaves are divided into four classes; first, the leaves at the top of the plant, which constitute the best quality, from the fact that they get more equally the benefit of the sun's rays by day and the dew at night; second, the leaves which are next to the above; third, the inferior or small leaves; fourth, the lug leaves, or those nearest the ground.

"The assorting of the plant, previous to putting in hands or bundles, is an operation that requires judgment and a practiced eye. This mode of assorting colors in stripping is similar to that of shading cigars, in which the utmost care is taken to keep the various colors and shades by themselves. Assorting the plant does not imply that it is carried to its fullest extent in point of color, as in shading cigars, but simply keeping those general colors by themselves, like light and dark brown leaves."

"*Packing.*—After the process of stripping is completed the hands should be packed to keep them moist, or as near possible in the same condition as when stripped. Select a cool, dry place in the center of the floor of the tobacco barn. It should be packed loosely or compact, according as the hands are moist and dry.

"Hand the tobacco to the packer, who presses the hands firmly with his knees and hands, laying the tobacco in two rows, keeping the pile about the same height, filling in occasionally with a middle row until all is packed. The different qualities should be packed separately. They can be packed any height or length desired, but usually from three to five feet high will be found convenient height, while the length may be proportioned to the height or not. After the tobacco is packed it should be covered with boards and gently weighted with stone or pieces of timber. If the tobacco is packed down in a good case, or keeping condition, which requires experience to determine, it can remain packed until ready for prizing."

"*Prizing, Casing and Baling.*—The term prizing originated in Virginia. In the sense in which it is to be taken here is a local word, which the Virginians claim the credit of creating. It is the act of pressing or squeezing the article which is to be packed into any package by means of certain levers, screws, or other mechanical force. This requires the combination of judgment and experience, otherwise the tobacco may become bruised.

"All leaf used for cutting purposes and export in America is prized in hogsheads. Cigar leaf is usually cased or baled. In some tobacco sections about 800 pounds net is packed in one parcel, while in others from 1,000 to 1,800 pounds. Tobacco in good condition to prize must be damp enough to bear the pressure without breaking and crumbling, while it must not be too moist or it will rot in the case.

"The hands or bundles are packed in the hogshead, or the case in two tiers; when nearly filled it is subjected to a strong pressure.

"The tobacco should be cased hard so that the mass will rise but little when the pressure is removed. When tobacco is prized or cased in the spring it will commence to 'warm up' as the summer comes, and will go through a sweat. After 'going through a sweat' the leaves will take on a darker color, and lose the rank flavor which they had before."

HARVESTING AND CURING.

The following notes on the above named topics are from a Bulletin of the Georgia Station:

"*Worming* is another point at which the beginner will fail if he is not made fully to appreciate the danger of great loss from this source. The most reliable safeguard against the horn worm is to have the crop to mature early. The moth makes its appearance as early as April and the few worms that result from the first eggs are apt to be overlooked by the beginner. But it should be remembered that one female worm destroyed in May is equivalent to the destruction of two hundred worms in July or August. It is the second brood that does the work of destruction, and the fight should be made on the first brood. The old method of poisoning the moth has probably not been improved on. It consists in planting out (early) a few dozen plants of the Jimson weed, and when the flowers commence to open inject into each of a few flowers left on each Jimson stalk a few drops of a sweetened solution of cobalt—a deadly poison. The moths are fond of the flowers, and the poison will prove their last feast."

"We have now reached a stage in the progress of the crop when the assistance or superintendence of an expert is essential to success. The processes of harvesting, curing, grading and packing require a knowledge and expert judgment that cannot be communicated in words or in print, but must be acquired by experience alone. A beginner may, indeed, visit a barn when the process is going on, and venture to proceed with his own crop without further assistance than the information thus gained, but he will probably find in the long run that it will pay to secure the services of a real expert curer to cure at least one or two barns, if not for the season. The latter plan is preferable if the owner has decided to go into the business of growing tobacco permanently and extensively, as he will thereby have the benefit of an entire season's training.

"Of course before the time of harvesting the farmer will have determined whether he will cure on the stalk or strip the leaves in the field as they successfully ripen, string them on wires and cure them. The former process, or 'stalk cure,' is the old established method of our fathers, and is still preferred and extensively practiced by many of the most influential tobacco growers. The 'leaf cure' is the modern process, and consists essentially in gathering leaves as they ripen, and leaving the stalks standing in the field. On the Station farm the 'modern process' alone was tried, and therefore no comparison of actual results can be drawn based on actual experiments.

"The *theory* of the 'leaf cure,' or 'modern process,' seems perfectly sound and logical, and it has been adopted in practice by many old tobacco growers, and no objections to it have been found in the experience of the Station tobacco growers. Whichever process may be adopted there is no essential difference in the construction of the barns.

"A close room 16x16 or 16x20 feet square, 18 to 24 feet high, with a brick or stone basement four or five feet high, and capable of quick and complete ventilation, seems to be the essentials.

"A barn may be built of small round logs. Build up seven feet high; then let in tier-poles across the building four feet apart; then three or four logs higher all around, and another set of tier-poles, and so on until there shall be four or five tiers; cover all with a tight board or shingle roof and chink and daub every crack, both inside and out. Cut out a hole on each side of the door, near the corner at one end, and build a brick or stone furnace eighteen inches high and the same width, and about five feet long, the mouth or door projecting about one foot outside the barn. Connect a ten-inch sheet-iron pipe to the inner end of each furnace; let it extend to within two feet of the opposite end of the barn, rising about one foot in that distance; then turn by an elbow at a right angle towards the middle, and then by an elbow returning to the front end and outside and into a chimney extending above the building.

"Patent or manufactured furnaces and flues cost more, but are better in the end. The 'Regulator,' made by Jordan & Easley, at South Boston, Va., is a good one.

"But a good framed barn, weatherboarded and ceiled, is better for permanent operations. The 'Modern Tobacco Barn' Co., High Point, N. C., will furnish plans and specifications and supply fixtures, furnaces, flues, etc., at reasonable prices for use in curing tobacco by the leaf cure process.

"To return to the curing process: A tobacco leaf is *ripe* when its color changes from the usual green to a greenish yellow and, sometimes, mottled appearance, and when it will break or crack open when folded and pressed between the thumb and finger, the under surface being outward. This occurs about five or six weeks after topping. When all the leaves on a stalk have reached this stage it is ready to cut. If the leaf cure is practiced when several leaves on many of the stalks are ripe they are ready to be plucked, and should then be immediately taken to the barn and the fires started as soon as the barn is filled.

"After warming up the barn for two or three hours at a temperature of about 90 degrees, advance the heat rapidly to 125 degrees, or as high as it will bear without scalding the tobacco, letting the heat remain at 125 degrees only a few minutes, and then by drawing the fires and opening the ventilators, cut off the heat and let the temperature of the barn descend to 90 degrees.

"This is generally called 'sapping.' The *rationale* of the process is this: The heat, by expansion, opens the sap cells and starts the water to the surface, facilitates evaporation and hastens the yellowing process. The 'limbering up' process, of high heat at the start, must be of short duration, else great injury will be done the tobacco.

"The heat is now held at 90 degrees for from eighteen to twenty-four hours, until yellowed sufficiently; that is, until the best leaves are of a uniform yellow, and the greener ones of a light pea-green color. Then advance the heat to 100 degrees, watching carefully for signs of sweating, which would soon redden and spoil the color, unless driven off. To do this open the door and let it stand open, and if after an hour the sweating has not subsided open cracks on opposite side of the barn, or the ventilators, to let in more air, until the tobacco has dried off all appearance of the sweat. This is a critical period, at which failure often occurs. Don't be in a hurry. More tobacco is spoiled by curing too fast than by going slow.

"Now close up the door and other openings, and raise the heat again to 100 degrees and keep it there for about four hours; then advance the heat by 2½ degrees every two hours until the thermometer marks 110 degrees. This is now the most critical point in the difficult process of curing bright tobacco. The condition and appearance of the tobacco must now be the curer's guide. No one can successfully cure tobacco until he can recognize the effects of too much or too little heat in the appearance of the leaf. Too little heat, in fixing the color, tends to stain the face side of the leaf a dull brown color, and is called 'sponging,' and may be known to the novice by its appearance only on the face side (upper) of the leaf. Too much heat reddens the leaf, first around the edges, and then in spots, which are visible on both sides. Now, to prevent sponging on the one hand and spotting on the other is the aim of the experienced curer. No definite time can be laid down to run from 110 to 120 degrees. Sometimes four hours will suffice; then again eight hours is fast enough. While it is usual at this stage to advance about 5 degrees every two hours for medium tobacco, its condition often indicates to the practiced eye the necessity for slower or faster movement. But it is safe not to advance above 110 degrees until the tails begin to curl up at the ends. Arrived at 120 or 125 degrees, this is the CURING process. The heat should remain at or near these figures until the leaf is cured, which will require from six to eight hours, according to the amount of sap in the leaf to be expelled. When the leaf appears to be cured then advance the heat, 5 degrees every hour, up to 170* degrees, and let remain until stalk and stem are thoroughly cured.

"To capitulate—

"1. 'Warming up:' 90 degrees, two or three hours.

"2. 'Sapping:' Advance rapidly to 125 degrees, hold five minutes, and then quickly back to 90 degrees, by drawing the fire and opening ventilators.

"3. 'Yellowing:' Hold at 90 degrees from eighteen to twenty-four hours.

"4. Fixing color: 100 degrees three or four hours; 100 to 110, 2½ degrees every two hours; 110 to 120, in four to eight hours.

***Capt. W. H. Snow says the heat should in no case exceed 135 degrees.**

"5. Curing the leaf: 120 to 125—six to eight hours.

"6. Curing stalk and stem: 125 to 170, five degrees an hour, and continue at 170 degrees until stalk and stem are thoroughly dry, which usually requires from twelve to fifteen hours."

NEVADA WEEDS.

I.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 21.

RENO, NEVADA, SEPTEMBER, 1893.

Agricultural Experiment Station.

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THIS WORK IS DONE GRATIS FOR RESIDENTS OF THE STATE.

The Bulletins and Reports will be sent free to any farmer or other person interested in agriculture within the State.

Address all communications to

Agricultural Experiment Station.
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Please acknowledge receipt of this Bulletin.

NEVADA WEEDS.

I.

F. H. HILLMAN.

INTRODUCTION.

The present bulletin is the first of a proposed series which will treat of the more noxious plants of Nevada. The author aims to enable the reader to recognize the various plants discussed, also their seeds or fruits. Indeed the practicability of the series is dependant upon such recognition. Doubtless the majority of readers can recognize these plants when seen in the field, but it is probably equally true that very few can recognize the seeds of these same plants. Prevention is better than remedy in dealing with most weeds, hence the power to distinguish between desirable and undesirable seed becomes necessary. To enable one to do even more than this and recognize as far as possible from these seeds, the particular plants to which they belong is one of the objects of this series of bulletins.

No new and infallible method for the isolation of seeds can be given, The use of graduated seives and fans probably will be found most efficient. In practice, the means at hand will best determine the method to be followed.

The order of treatment of the different species will be dependent upon the facilities for illustration at hand at the time of preparation of the subject matter. This, however, will prevent the consecutive arrangement of allied species which would be most desirable.

Objective illustrations will be given when circumstances will permit.

The descriptions of the various plants and their seeds will be couched in popular language as far as possible and will embody only the most salient characters. F. H. H.

THE PIGWEEDS.

These are among the commonest of weeds and are found in all of the more settled parts of the country. They are confined almost wholly to recently cultivated lands thus interfering most with annual growing crops. Meadows, pastures and grain fields are little troubled by them. All are annual plants with inconspicuous flowers. They appear early in Spring and by mid-Summer have partially flowered. A part of the seed is soon ripe and from this time till the frosts of Autumn kill the plant, there is a continuous production of seed. The seeds are small, and though but one is produced from a single flower, an immense quantity is yielded by a normally sized plant.

The true pigweeds belong to the genus *Amarantus* of the Amaranth family, AMARANTACEÆ. Of these, four species are very common here. Another so-called pigweed is *Chenopodium album* of the closely allied family CHENOPODIACEÆ, the goose-foot family.

THE AMARANTHS.

The flowers are polygamous, i. e. some perfect and others unisexual (mostly unisexual in the following species); the ripened staminate flowers falling early; the floral envelope irregular, consisting of 3 or 5 sepals; the floral bracts slender and sharp pointed becoming rigid and prickly on ripening; the seed capsule breaks open transversely at maturity allowing the seed to escape. The seeds of the following species are similar in structure and appearance, but vary somewhat in size.

Amarantus retroflexus, L.

COMMON PIGWEED, ROUGH AMARANTH.

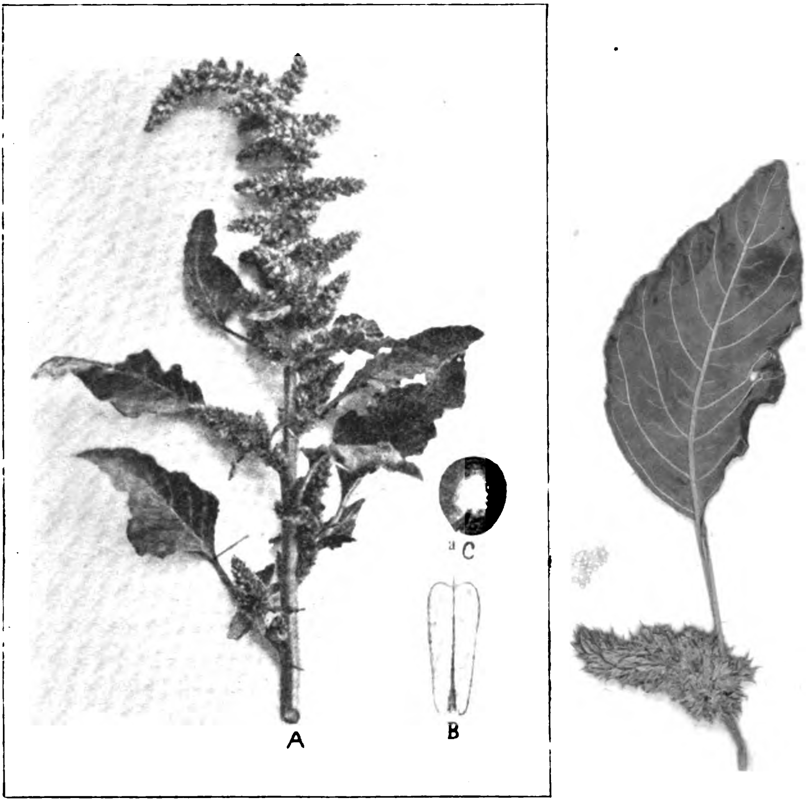

FIGURE 1.

Plant an annual, one to three feet high, the strong tap root several inches long and bearing numerous branches; the stem at

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FIG. 1. *Amarantus retroflexus,* L. A, the upper part of the plant showing the arrangement of flowers in short compact spikes. B, a sepal. C, a seed magnified. a, notch in the side of the same.

first simple, erect, branching mostly from below later, covered with fine hairs *which give a decided roughness to the mature stem;* the leaves arranged alternately, one to three inches long, ovate, undulate, the venation prominent; the flowers very numerous, compactly arranged in *short thick spikes,* the terminal spike little longer than the lateral ones.

Seeds. Small, somewhat flattened, slightly irregular in outline, shining black, smooth, the average diameter determined from numerous measurement of seeds in quantities approximately one-thirtieth inch.

Amarantus chlorostachys, Willd.
COMMON PIGWEED.

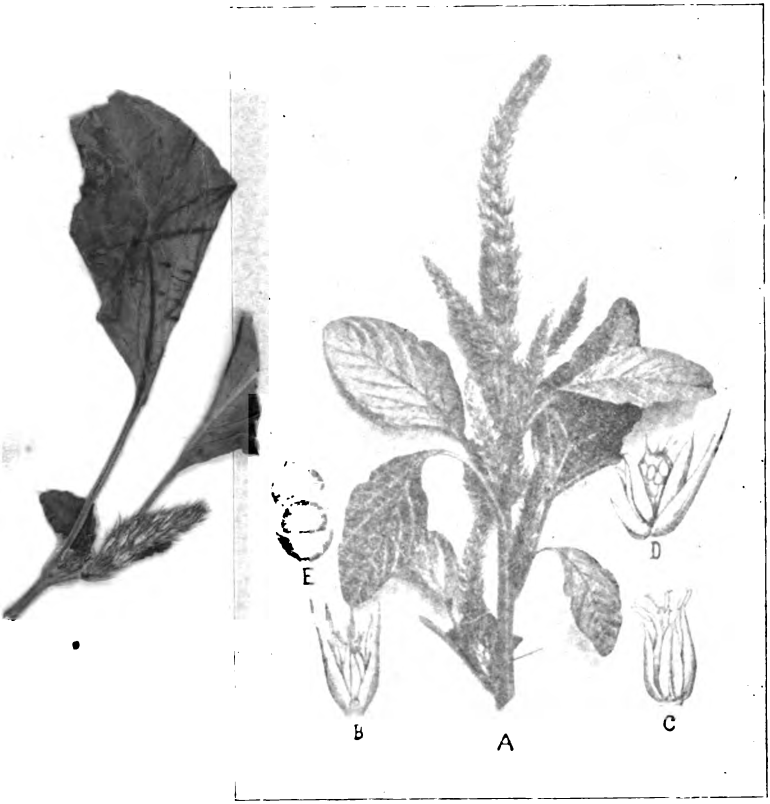

FIGURE 2.

Plant an annual, very similar to the last in general structure, size and appearance, lighter green, often tinged with red, almost smooth; the floral spikes longer and slenderer, the terminal one apt to be more flexuous than the preceding.

Seeds. So similar to the last as to be almost indistinguishable from them. They are, however, somewhat larger.

FIGURE 2. *Amarantus chorostachys,* Willd. A, top of plant showing characteristic form of floral spikes and leaves. B, an individual flower cluster. C, a staminate flower. D, a pistillate flower showing sepals and bract. E, a seed capsule broken open transversely. (All the species of Amarantus share this character in common)

Amarantus blitoides, Watson.
LOW AMARANTH.

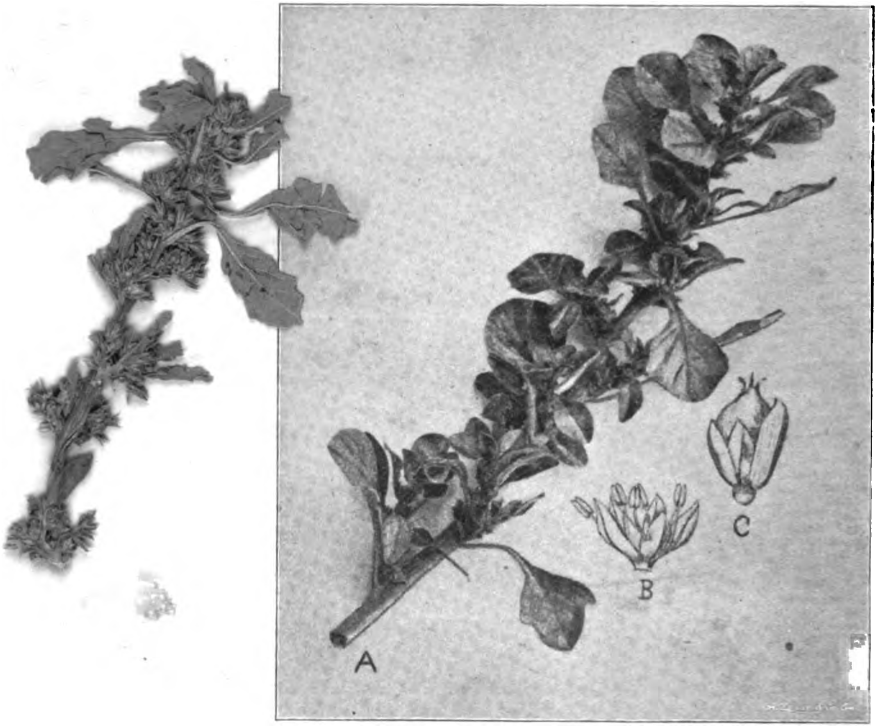

FIGURE 3.

Plant an annual, low and spreading, six to eighteen inches high, in general appearance quite different from the two preceding species; branches weak, prostrate or more usually decumbent, the presence of a main stem usually lost among the many low branches; leaves from half an inch to one and a half inches long, ovate or spatulate, less undulate than in the preceding, the light colored veins prominent on the under side; flower clusters small in the axils of the leaves, distributed along the greater part of the length of the branches; floral bracts *shorter than the flowers*, not so prickly when ripe as the preceding.

Seeds. These have all the characters of the preceding, but are considerably larger. Their diameter approximates one-twentieth of an inch. The are the largest of the seeds of the four species of *Amarantus* here discussed.

FIGURE 3. *Amarantus blitoides*, Watson. A, extremity of a branch showing leaves and flower clusters. B, a staminate flower. C, pistillate flower.

Amarantus albus, L.

WHITE PIGWEED, TUMBLE WEED.

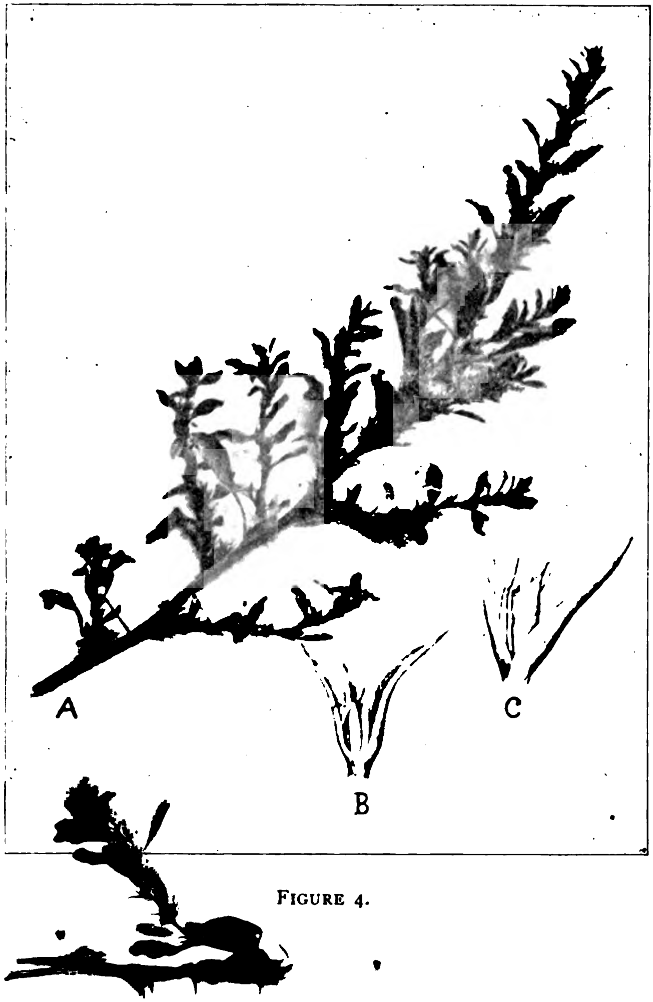

FIGURE 4.

Plant an annual, more slender than the last, lighter green, diffuse in growth, the main stem bearing many ascending

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FIGURE 4. *Amarantus albus*, L. A, extremity of a branch. B, a single flower cluster. C, a staminate flower with its long bract. Specimen of a branch. Seed of the same.

branches; leaves from half an inch to one inch long, spatulate, rather inconspicuous; flowers in small axillary clusters; calyx of three nearly equal sepals (five and unequal in the others); the floral bract twice longer than the flower, becoming prickly when dry.

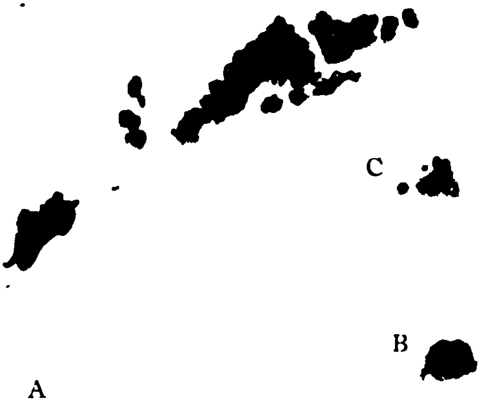
Seeds. Similar in general appearance to the preceding, but much smaller. These average approximately one-thirty-fourth of an inch in diameter.

A NOXIOUS GOOSE-FOOT.

The family CHENOPODIACEÆ is closely allied to the AMARANTACEÆ and the mode of life of the following representative is very similar to that of the foregoing species. The species of this family commonly termed a pigweed is,

Chenopodium album, L.

GOOSE-FOOT, PIGWEED, LAMB'S QUARTERS.



Plant an annual, erect, two to five feet high; root strong and branching; the stem branching profusely with age and often

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Specimens of *Chenopodium album*, L. A, a piece of a branch. B, seeds with the dried floral envelope remaining. C, the same with the floral envelope removed.

variegated with red, green and purple; leaves petiolate, one to two and a half inches long, ovate in outline, notched on the sides, the upper narrower; the younger leaves and flower clusters present a mealy appearance not to be observed in any of the preceding species; the individual flowers are inconspicuous, but the flower clusters become more prominent than the leaves.

Seeds The seeds proper of this species are very similar to those of *Amarantus*, inasmuch as they are flattened, have a shining surface, and are of about the same size. The seed proper does not separate easily from the ripened floral envelope which gives a grooved and light green appearance to the seed. With this covering removed the seed is usually still closely invested by a thin, dark ash colored covering, the wall of the seed capsule. This is often ruptured allowing the shining coat of the true seed to appear. This covering does not materially change the shape of the seed and but slightly increases its size. With this included, the approximate diameter of a seed of this species is one-twenty-fifth of an inch.

KNOT-WEED AND DOCK.

These plants, like the preceding species, are common everywhere and so are well known. They belong to the buckwheat family, the POLYGONACEÆ. Their habits differ distinctly, but their seeds are so similar as to require comparative examination in order to be distinguished.

Polygonum aviculare, L.

Knot-weed, Knot-grass, Door-weed.

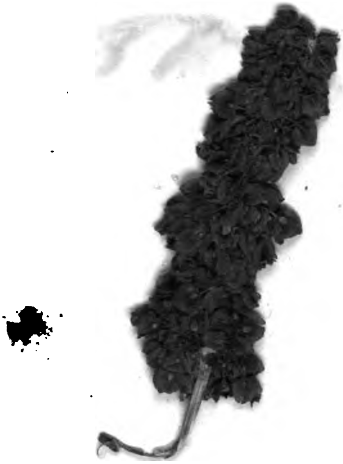
Plant an annual, low, spreading, sometimes erect or ascending and a foot or eighteen inches high in shaded places; root strong, several inches long, firmly fixed in the ground; stems, several from a common point just above the surface, smooth, striate, branching; leaves alternate, one-half inch to one and a half inches long, short stemmed, smooth except the edges, acutely-elliptical in outline, their stipules papery, sheathing the stem, the margins deeply torn; flowers small, greenish-white, inconspicuous, two or three clustered in the axils of the leaves. A common plant along drives and walks where it becomes troublesome. It thrives on newly seeded land, but eventually becomes crowded out if the land is well seeded to grass or clover.

Seeds. Triangular, pointed at the extremities, one extremity more blunt than the other, this usually bearing a part of the floral envelope which has mainly fallen away, *the angles blunt*, normal color at maturity dull, dark brown. There is considerable variation in the sizes of these seeds. The average length ranges between one-twelfth and one-tenth of an inch. Often the floral envelope is persistent, in which case the size is greatly increased.

Specimens of *Polygonum aviculare*, L. An extremity of a branch showing the leaves. Seeds of the same.

Rumex crispus, L.

CURLED DOCK, RED DOCK.



Plant a perennial; root strong, half an inch or more in diameter, firmly fixed in the ground; stem one to three feet high, smooth striate, becoming reddish with age; leaves smooth, six to twelve inches long, those among the flowers much shorter, lanceolate, the edges wavy; the flowers forming at first a loose panicle, later a dense brush occupying nearly the upper half of the plant; individual flowers drooping on slender stems, the inner three divisions of the floral envelope the larger, and each usually having a thickened spot in the center; these persistent flowers becoming reddish tinged at maturity. This plant is commonest in meadows and pastures where it appears from year to year from the same root. To eradicate the plant, the root must be destroyed.

Seeds. Very similar to the last, free from an adhering portion of the floral envelope, *the angles thin and acute*, color light brown or reddish. The size of these is approximately that of the preceding species.

Specimens of *Rumex crispus*, L. A piece of a flower stalk bearing nearly matured flowers. Mature seeds of the same.

MULLEIN.

The common mullein is a well known pest in the East where it is very generally distributed. As yet, it seems to be only locally abundant in this part of Nevada. However, where it has gained a foothold, it seems to thrive and spread rapidly. Our climate and soil seem to be well adapted to its growth judging from the tall sturdy plants usually found. It is a biennial plant appearing first as a tuft of large, light green, woolly leaves. During the first year a strong root is developed. The second year the stalk is developed. This exhausts the root which dies at the close of this season. The mower prevents the development of the plant in the meadow, but in the neglected pasture and along roadsides, the plants thrive for years if undisturbed. Thus persistently cutting down the stalks during the second year will destroy this plant while similar treatment is unavailing in the case of the preceding perennial plant, *Rumex crispus*. The mullein belongs to the genus *Verbascum* of the Figwort family, the SCROPHULARIACEÆ. Another species of the same genus is becoming exceedingly noxious in portions of the East, but as yet is not reported as found in this region.

Verbascum thapsus, L.

COMMON MULLEIN, VELVET-LEAF.

A biennial plant, two to six feet tall, slender, usually with a single stalk, this sometimes branching however; leaves varying in

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Specimens of *Verbascum thapsus*, L. A portion of the velvety leaf peculiar to this plant. Seeds of the same.

size, the lower often attaining a length of ten inches or more, becoming smaller above, oblanceolate, margins entire, the bases of the stem leaves extending down the stalk giving it a winged angular appearance, *all the leaves densely woolly on both sides;* flowers yellow, inconspicuous, forming a dense spike from several inches to two feet in length, this giving the upper part of the mature plant a club-like appearance. The prominent slender shafts of these mature plants stand as lone sentinels over their surroundings till broken down by the storms of winter.

Seeds. These are yielded in enormous quantities. They are light and easily distributed by winds. In size they are somewhat variable, but this matters little in the work of separation as they are all extremely small. The seed is cylindrical, blunt at the usually unequal extremities, longitudinally grooved, the intervening ridges more or less rough. The approximate length is one-fortieth of an inch, the width two-thirds as great. Their minute size and lightness permit most efficient use of sieves and fans in their isolation.

NEVADA WEEDS.

II.

UNIVERSITY OF NEVADA.

Agricultural Experiment Station.

BULLETIN NO. 22.

RENO, NEVADA, DECEMBER, 1893.

Agricultural Experiment Station.

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Address all communications to

AGRICULTURAL EXPERIMENT STATION.
Reno, Washoe County, Nevada.

Please acknowledge receipt of this Bulletin.

NEVADA WEEDS.*

II.

F. H. HILLMAN.

INTRODUCTION.

This second number of the series of Nevada Weeds discusses fewer species than its predecessor. The habits of these plants are more diversified also, as no two are of the same genus, and the three families represented differ so widely in structural characters and habits as to result in their bearing distant relationships. As these plants are mentioned in lists formed in the early years of the State, they appear to be old settlers. However they have not simply perpetuated their kind; but, apparently, have flourished and extended the confines of their distribution with the growth of agricultural industry.

In this distribution of plants doubtless no insignificant part has been played by the thousands of mining prospectors, who with their pack trains have thoroughly traversed even the most uninviting localities in their search for precious metals.

It is instructive to note the various kinds of natural provision for the propagation and distribution of plants partially illustrated by the species here enumerated. Thus *Iva axillaris*, of the composite family, produces but a moderate amount of seed, yet by means of creeping under-ground stems which send up young shoots, many plants are produced by a single individual without the intervention of seed. *Hordeum jubatum*, of the grass family, is carried far and wide by the winds, and *Franseria Hookeriana*, of the Compositæ, is disseminated through its burs which cling to the coats of passing animals. The seeds of *Capsella bursa-pastoris* and *Lepidium intermedium* (?) of the mustard family, are not so well provided for in respect to their distributive facilities. Their seeds are, however, often blown about by the winds as they adhere to parts of their light buoyant pod. The lack of provision for distribution in these species is somewhat compensated for by the immense quantity of seed produced by them.

F. H. H.

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*The illustrations presented in this bulletin are from plates kindly loaned by Professor Charles S. Crandall of the Colorado Experiment Station.

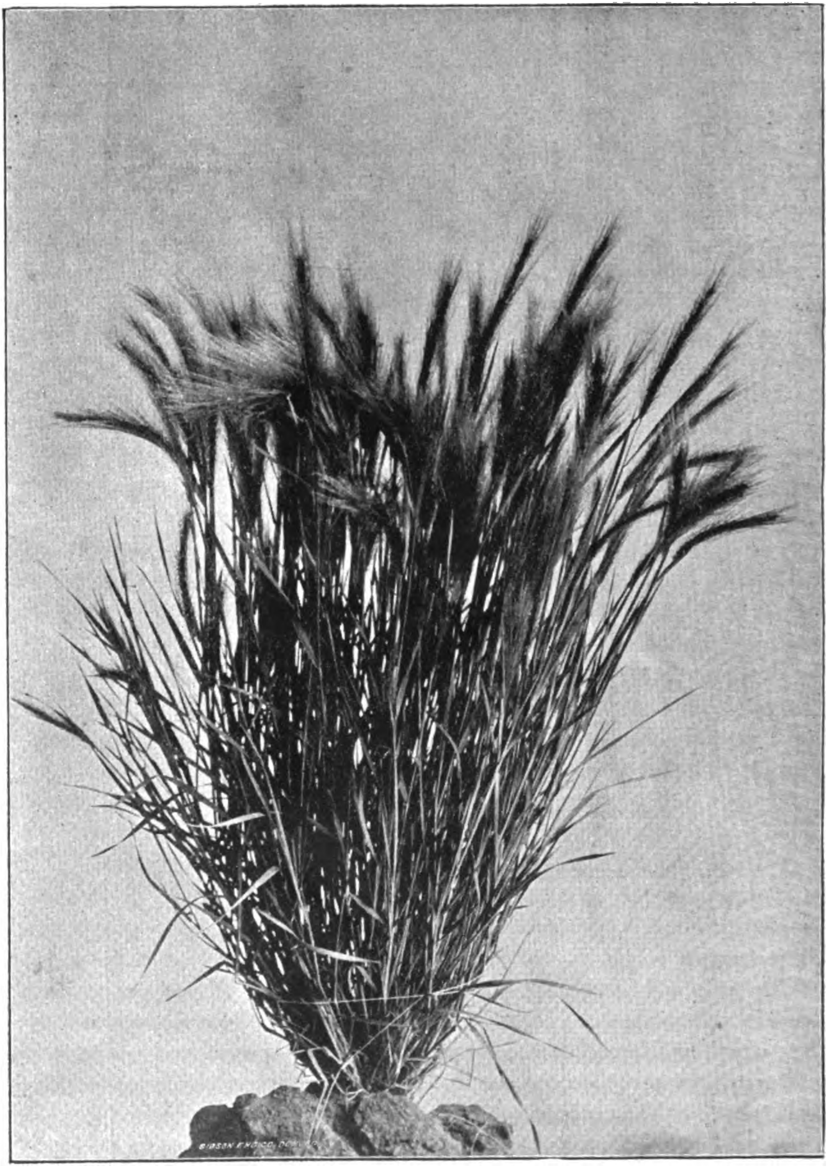

PLATE 1.

Hordeum Jubatum, L. (*Plate 1.*)

SQUIRREL-TAIL GRASS, TICKLE GRASS.

This is one of the true annual grasses and is very generally distributed throughout the country. It appears in meadows usually in thick stools. The plant stands erect, from a span to eighteen inches high, the glistening, wavy heads presenting a pretty appearance notwithstanding the plant's noxious character. The stems and leaves are light green, roughish to the touch; the heads of flowers are lighter green, often purplish tinged; at maturity the flower heads break up into sections bearing a single seed each. Each section consists of a short portion of the flower stem barbed by short, stiff hairs along its edges; this bears seven long slender awns, one of which is expanded at the base and contains the seed; each of the awns is barbed.

This is considered the worst weed in Nevada. It spreads easily and rapidly. Its presence in the meadow depreciates the feeding value of hay as the barbed awns lodge in the mouths and throats of animals and produce angry sores.

The farmer may, with care, keep his meadow free from this pest, but his neighbor's well stocked field may make ultimate eradication hopeless. Plants should be pulled and *burned before the heads appear* as the seed is fertilized very early and the plant's power of seed development is very great.

The destruction of this pest is a most fitting subject for legislative action by which concerted effort in this direction will be required and enforced.

The Fruits, or sections of the flower-head bearing a seed are made buoyant by the long awns and the barbs of the short stem serve to fasten the seed in the ground. Thus nature has made ample provision for the distribution of the plant. An average head produces from fifty to sixty seeds. The seed proper is not likely to be found intermingled with other seed as it is firmly held by its investing floral organs which cause its separation in fanning and sifting.

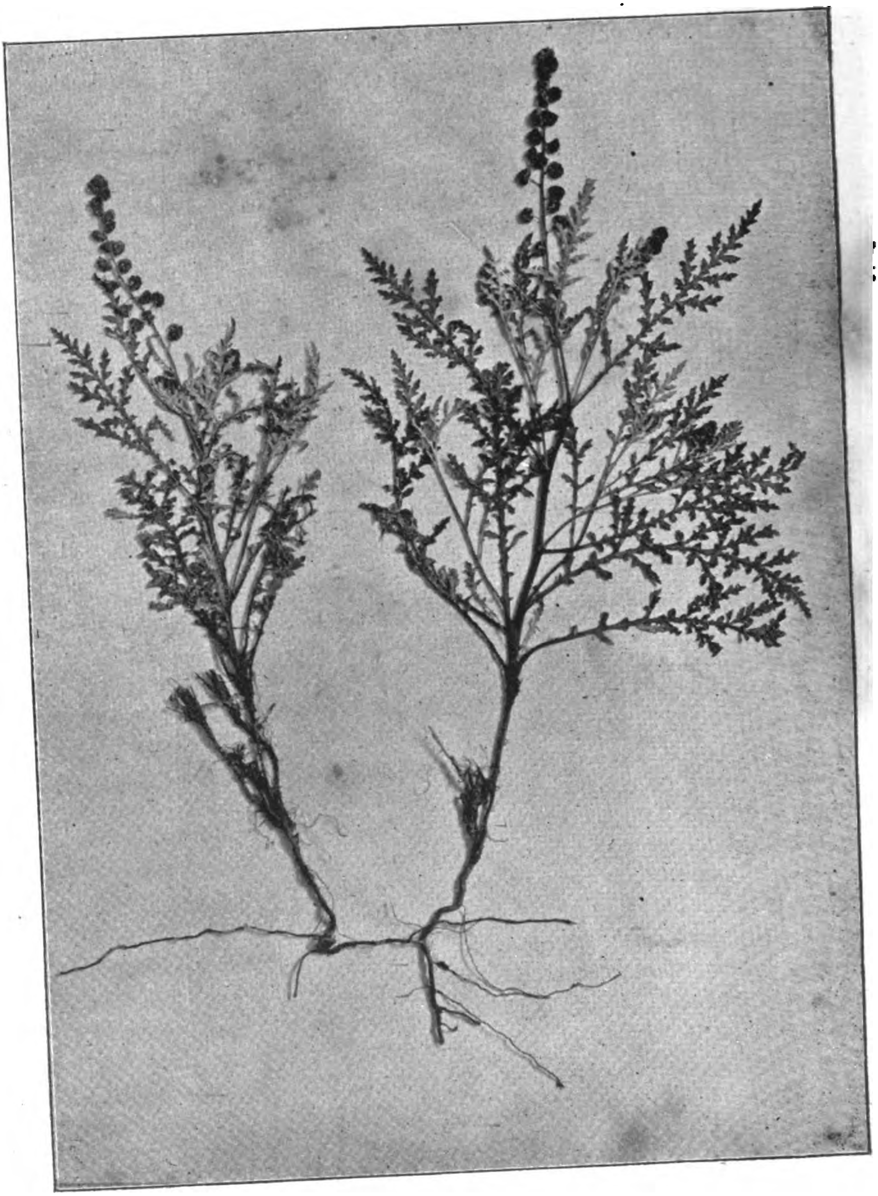

PLATE 2.

Franseria Hookeriana, Nuttall (*Plate 2. F. discolor.*)*

This is an annual plant which has no common name apparently. It seems to be very generally distributed in this region, but as yet is confined to restricted areas. The writer has found it most common along roadsides where its burs are most easily caught by the wool of passing sheep.

The plant grows from a foot to four feet high; branches diffusely from near the ground; the stems are rough to the touch while the leaves are covered by minute white hairs, giving to them a somewhat silvery appearance; leaves more or less divided into three parts, the parts themselves toothed or variously notched; the longer ones three or four inches long on slender stems. The burs are arranged along the branches singly or in clusters, the fertilizing staminate flowers constituting a slender cluster above the burs.

The plant is not naturally provided for rapid dissemination, but the readiness with which the plants develop when they have once gained a start makes them well worthy of consideration as bad weeds.

The Fruit is represented in the burs, each of which contains a single seed. Each bur bears several strong extremely sharp pointed spines. The burs will scarcely allow the seed to appear in purchased field seed.

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*The plate gives a very good idea of a young plant of F. Hookeriana, which does not have the creeping under-ground stems of F. discolor; but, instead, a slightly branching annual root.

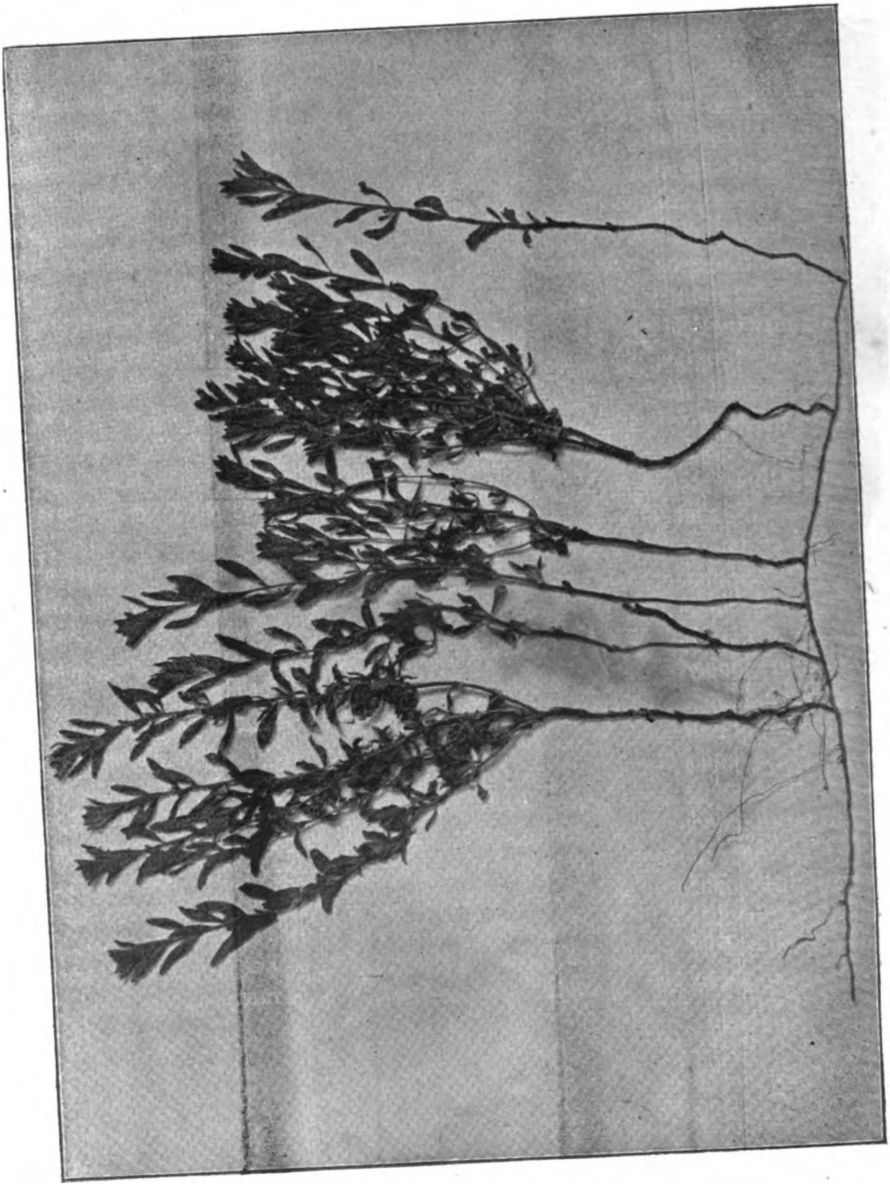

PLATE 8.

Iva axillaris, Pursh. (*Plate 3.*)

POVERTY WEED.

This plant is closely related to the preceding. Its noxious character, however, does not lie in its fruits as in the other, but rather in its power to spread and occupy the soil to the exclusion of other plants. The plant is herbaceous, six to twelve inches high, from creeping under-ground stems. The individual stems above ground branch but little. The leaves are arranged oppositely below and alternately above, those below an inch or more long, the upper becoming shorter toward the apex of the stem. They are simple acutely elliptical or oblong in outline, short stemmed, rough hairy, only the mid-vein showing distinctly. The flowers are in short stemmed, recurved or pendulous heads, in the axils of the upper leaves.

This plant is confined chiefly to the Western States. It thrives in nearly all soils and spreads rapidly when once established. Its vigorous under-ground stems demand that the soil be thoroughly cleared of all traces of these if the plant is to be exterminated.

Seeds. The seeds or fruits are produced in small quantity, only one to three or four in each head. These are somewhat pear-shaped and about 1-12 inch in length. They are slightly rough and reddish brown to black in color.

Capsella bursa-pastoris, Mœnch.

SHEPHERD'S PURSE.

This is an annual plant which is found the world over. It is not necessarily one of our worst weeds. However, its ease of growth permits it to occupy the soil often to the detriment of more valuable plants. This is especially true of newly made meadows and lawns. If prevented from going to seed, it may be pretty effectually kept in subjection locally. The plant stands a foot or two high; its branches spreading, mostly from the base. The leaves mostly from the base, two or three inches long, oblanceolate, toothed or more deeply cut; the stem leaves narrow, short, clasping the stem at the base. The flat triangular pods are numerous scattered along the slender upright leafless flower stems. Flowers white in a crowded bunch at the apex of the stem. The plant appears in April and flowers throughout the summer.

Seeds are very small, yellow in color, smooth and produced in large quantities. They are easily separated in sifting.

Lopidium intermedium, (?) Gray.

PEPPER GRASS.

An annual plant closely related to the preceding. It is from six inches to a foot high; branches profusely from a main upright stem. Its leaves are simple, alternate, slender, one to three inches long, with toothed or entire margins. The main stem and branches are terminated by a slender cluster of pods which presents at the extremity a compact cluster of minute insignificant flowers. These differ from those of the preceding plant in having no petals and but two stamens. The mature pods are flat, almost circular in outline, and from one and a half to two twelfths of an inch in diameter. This particular species belongs chiefly to the Pacific Coast. Its genus is very generally distributed throughout the United States, however.

Seeds, very similar to the last in general appearance but larger.

SUGAR BEETS.

UNIVERSITY OF NEVADA.

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Agricultural Experiment Station.

BULLETIN NO. 23.

Reno, Nevada, December, 1893.

Agricultural Experiment Station.

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SUGAR BEETS.

N. E. WILSON.

During the seasons of 1891 and 1892 extensive experiments were carried on both at the Station grounds and in co-operation with the farmers in different sections of the State. The results, which have been published in bulletins 13 and 19, were very encouraging and it was thought best to continue the experiments during the season of 1893, but on a smaller scale. The publication of the results of these experiments closes the work of the Station in this special line. It now remains for the people of the State to decide whether the data thus furnished gives sufficient proof that the Beet Sugar industry would be profitable for this State. The Station will be ready, at all times, to furnish any available information upon the subject of Beet Culture and Sugar Manufacture to all who are interested in the matter of establishing the industry within the State. Beets will be grown on the Station Farm for some seasons to come, under various conditions which may be suggested from time to time. We give below results of analyses for 1893, and for convenience of reference (the edition of Bulletin No. 13 being exhausted), we reprint as an appendix the results of 1891-92.

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
523	Frank Francis	Lovelocks				9.20	6.50	70.65
524	Frank Francis	Lovelocks				10.80	7.20	66.66
525	Frank Faancis	Lovelocks				10.40	6.00	57.70
526	Frank Francis	Lovelocks				10.20	8.00	78.44
527	Frank Francis	Lovelocks				9.80	7.00	71.44
528	Frank Francis	Lovelocks				10.40	6.90	66.35
529	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener		7⅞	24.20	20.20	93.66
530	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener		13	23.40	19.80	84.62
531	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener		6¾	16.00	14.50	90.66
532	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener			16.80	15.00	94.06
533	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener		8 5–16	17.80	13.20	74.26
534	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener		14	17.40	15.30	87.95
535	E. E. Jones	Blaine P. O., Elko county	Verbesseter Klein Wanzlebener			18.20	14.50	79.68
536	J. M. Newlands, Jr	Chino Ranch, Chino, Cal				16.60	13.30	80.14
537	J. M. Newlands, Jr	Chino Ranch, Chino, Cal				17.60	14.50	82.39
538	Station Farm	Reno, Nev	Klein Wanzlebener		4 15–16	21.30	18.20	85.44
539	Station Farm	Reno, Nev	Knauer's Imperial		3⅜	22.50	19.20	85.32
540	Station Farm	Reno, Nev	Vilmorin Amelioree		4 15–16	23.70	20.80	87.78
541	Station Farm	Reno, Nev	B. 5. (For dry land.) Chino, Cal		4¼	24.00	20.90	86.87
542	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener		3 1–15	23.90	20.90	87.43
543	Station Farm	Reno, Nev	C. P. 2, P. A. Chino, Cal		5⅜	24.10	21.10	87.55
544	Station Farm	Reno, Nev	B. A. Simon La Grande, Chino		4 9–16	24.35	21.20	87.15
545	Station Farm	Reno, Nev	L. R. Chino, Cal		4 11–48	23.60	20.50	86.87
546	Station Farm	Reno, Nev	Vilmorin Richest		2⅝	24.30	21.80	89.72
547	Station Farm	Reno, Nev	Desprez G. Island		4⅞	23.90	21.20	88.69
548	H. N. Fuss	Lovelocks	Vilmorin Ameliorее	1	4	12.10	8.48	70.08
549	H. N. Fuss	Lovelocks	Vilmorin Ameliorее	1	6	14.10	9.50	67.37

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs.	Ozs.			
550	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	8	12.50	7.20	57.60
551	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	10	12.10	7.10	58.68
552	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	3	14.00	10.40	74.28
553	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	6½	12.00	10.10	66.85
554	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	2¾	16.00	12.50	78.12
555	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	9¾	13.90	10.40	74.81
556	H. N. Fuss	Lovelocks	Vilmorin Ameliore	.....	.....	14.90	10.00	67.11
557	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	11½	14.20	11.00	77.46
558	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	15	13.90	9.20	66.19
559	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	12½	14.70	12.10	82.32
560	H. N. Fuss	Lovelocks	Vilmorin Ameliore	...	15½	18.80	12.50	66.48
561	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	1½	16.40	12.70	77.44
562	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	⅛	21.00	15.50	73.80
563	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	12⅝	....	15.40	....
564	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	8¾	22.00	15.00	68.18
565	H. N. Fuss	Lovelocks	Vilmorin Ameliore	2	3¼	19.60	13.50	68.86
566	H. N. Fuss	Lovelocks	Vilmorin Ameliore	2	10½	14.40	8.00	54.05
567	H. N. Fuss	Lovelocks	Vilmorin Ameliore	3	3½	15.60	7.00	44.87
568	H. N. Fuss	Lovelocks	Vilmorin Ameliore	2	1⅛	17.20	9.50	55.23
569	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	11¾	16.00	7.90	49.37
570	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	15¾	20.80	13.00	62.49
571	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	12⅜	20.60	13.00	63.10
572	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	10 7-16	18.00	12.50	69.44
573	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	15 13 16	18.80	13.50	71.80
574	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	7⅞	18.00	12.00	66.66
575	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	8 3-16	18.00	13.00	72.21
576	H. N. Fuss	Lovelocks	Vilmorin Ameliore	1	5¾	15.20	12.00	78.95

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSIS.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
577	H. N. Fuss.......	Lovelocks.......................	Vilmorin Amelioree............	1	4¾	19.00	12.30	64.73
578	H. N. Fuss.......	Lovelocks.......................	Vilmorin Amelioree............	1	7 1-16	14.40	6.60	45.82
579	H. N. Fuss.......	Lovelocks.......................	Vilmorin Amelioree............	1	1 5-16	20.40	11.80	57.85

EXPLANATION OF TERMS USED IN TABLES.

By "total solids" is meant the entire amount of solid matter (sugar and other substadces) in 100 parts of the juice; in other words, the residue left on evaporation of water from the juice. By sucrose is meant the amount of crystalizable sugar in 100 parts of the juice. By purity is meant the amount of sucrose in the entire solid matter of the juice; to illustrate: Beet No. 530 analyzed 23.40 per cent total solids, 19.80 per cent sucrose, purity 84.62 per cent. This means that in every 100 pounds of the beet juice there are 23.40 pounds of solid matter and 19.80 pounds of sugar; also that in every 100 pounds of the solid matter there are 84.62 pounds of sugar, or that the juice has a purity of 84.62 per cent.

The averages of analyses for the three years in which the experiments have been conducted are as follows:

Season.	Sucrose. Per Cent.	Total Solids. Per Cent.	Purity. Per Cent.
1891..............	13.20	17.17	76.87
1892.......	15.56	17.71	80.76
1893.	14.23	17.62	80.76

In making up the average for 1893 the first six samples (numbers 523 to 528 inclusive) were not considered, as they were not nearly matured and were sent in after but two months' growth simply to ascertain how the sugar development was progressing. The results for 1893 are not as good as for 1892, due undoubtedly to lack of proper attention to the minute details of thorough cultivation and irrigation. During the three seasons of experimentation 487 samples have been analyzed, and we give below a table of classification showing the number of samples which would have been profitable for manufacture and those which would not have been, 12 per cent. being the minimum working percentage.

	CONTAINING PERCENTAGE OF SUCROSE.		
Season.	Below 12 per cent.	From 12 to 18 per cent.	18 per cent. or Over.
1891....	67	97	47
1892.........	18	111	91
*1893.... ...	22	23	12
Total........	107	231	149

This is a very good showing and indicates what can be done in the way of beet culture in this State. Thus far no disease has appeared among the beets raised in the State, we have yet to find the first scabby beet. Numerous reports of depredations by ground squirrels or "gophers" from all parts of the State have come in. In some cases the total crop was destroyed.

We again call attention to Carbon Bi-Sulphide as an exterminator of this pest. Full details for its use are given in Bulletin No. 19, pages 11 and 12, which will be sent free upon application.

SOIL FOR SUGAR BEET CULTURE.

The question of the proper soil for this purpose has been the subject of much discussion, and it is generally conceded that the best soil for beets is a moderately light sandy loam, ploughed deep. The beet in growing, from germination to the harvesting period, requires a soil of such a texture that but little resistence will be

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* Including No. 523 to No. 528 inclusive.

offered, as otherwise the root instead of being long and thin would be short and thick, which is very undesirable. A stony soil is also to be avoided as small stones are apt to cause forked roots by the root growing on either side. Sandy soils from alluvial deposits give most excellent results. Such soils are not abundant, so soils of other characteristics are necessarily the ones we must have most to do with, this is especially true in Nevada. The clay soils are not well adapted for the beet as they offer too great resistence to the root, but when combined with another lighter soil gives very good results. The clay-lime soils (argillo calcareous) carry about thirty-three per cent clay and forty-five per cent sand with carbonate of lime and are very good beet soils, although not typical soils for the purpose. In no case should beets be planted on muck lands or old peat beds as the excess of nitrogenous matter is very injurious, causing impure juices, etc. Whatever the physical or chemical properties of a soil may be, if not ploughed in a proper manner so as to permit of free penetration of the air, the desired results cannot be obtained.

CARE OF BEETS.

As has been stated in our previous bulletins on the subject, the "sugar beet is a thoroughbred and must be treated as such." The horse, the ox or the dairy cow to produce the best results must have proper care; so it is with the sugar beet. From the first days of the young plant to the maturity of the beet one must give that care and attention to the minute details of cultivation which tends toward the greatest possible elaboration of saccharine matter. Although, as Mr. Gird of the Chino Ranch says, "the sugar beet is a particularly hardy plant, adjusting itself without difficulty to conditions of soil and climate with extreme tenacity of life, and succeeding where many other agricultural plants would, under the same conditions, be a total failure. It is also a plant, the cultivation of which under the scientific methods necessary to its success, increases the productiveness of the ground for other crops, and makes such a division and increase of labor to a given area as to help solve the question of profitable employment and of the instillment of those habits of industry into the rising generation which at present seems such a difficult problem in our industrial labor system." There is no doubt but that a very large loss of sucrose takes place between the field and the factory, equal to if not greater than the loss of manufacture. The common practice of digging beets and allowing them to lie in the field exposed to the sun, then dumping them in sheds by the hundreds and thousands of tons where they remain for perhaps a week or ten days before being worked up, causes fermentation, which means a loss of sugar and difficulties in manufacture, ail of which the shrewd farmer and manufacturer should desire to prevent.

Dr. Walter Maxwell, Assistant Chemist U. S. Department of Agriculture, in charge of the Department of Sugar Stations at Schuyler, Nebraska, has conducted some very striking experiments, from which may be obtained some good ideas on the care of beets from the time of harvesting to the time of working up by the factory.

We give herewith Dr. Maxwell's figures, together with his own description of the experiments as it appears in the *Louisiana Planter:*

SPECIAL EXPERIMENTS WITH SUGAR BEETS.

During the analytical seasons of 1891 and 1892 certain special experiments were conducted with the purpose of determining the loss of weight of the beet by evaporation and the cause of the loss of sugar which takes place in the organism, particularly during that interval of time between the removal of the beets from the soil and the period of storage in the silos· By means of those experiments it was shown conclusively that high temperature, and particularly the action of strong sunlight, are the primary causes or the decomposition of the sucrose, and that a system of cold storage would effectually protect the organism against such a change in its constituents and the resulting loss of sugar. Those experiments afforded such conclusive data that it has not been considered necessary to continue the experimentation along that particular line this season.

I, however, conducted a series of experiments in order to obtain light upon one other highly important question. It has been, and is still maintained, and by very noteworthy authorities, that excessive moisture falling upon the beets, either before or after their removal from the soil, causes a decrease or loss in the content of sugar and a signal depreciation in the quality of the beet. The observations made in the experiments of last year and which are found in the report showed conclusively that the fall tn the sucrose content of the juice after rains was invariably accompanied by a corresponding, or even greater increase in the weight of the beet. These observations caused me to doubt wholly the accepted conclusions concerning the action of moisture upon the sugar content. Moreover, there does not appear, physiologically, a probable expectation that such action would transpire. There is, on the other hand, reason for supposing that a deficiency of moisture would retard the formation of sucrose; first, because a normal water content is essential to the elaboration and transport of the constituents in the organism; and further, an excess of water is indispensible to the formation of the carbohydrates. Scientifically speaking, we have in these considerations the explanation of the decrease of sugar which took place this year in September, of which I have already exhaustively spoken.

This year the specific object was to observe the action of water upon the organism of the beet. The season was peculiarly favorable to the purpose. The experiments were commenced at the period when, as previously related, the beets were depreciating under the influence of drought and heat. The experiments were conducted by taking up a given number of beets, dividing the number into two or more identical parts, and analyzing one part immedialely and placing the other part under the action of excessive moisture until analyzed after a definite lapse of time. The work of dividing the original number of beets into identical halves was conducted according to the method used last year, and which was based upon the physiological constant that I had observed, viz.: Any two or more lots of beets taken from the same plat and containing the same number of individuals and having the same weight will contain the same total solids and sucrose. Without some such constant, comparative tests would be strictly impracticable, as there would not be a standard of comparison. The constant, whose principle I have expressed, afforded the standard required.

In the examples to be given the beets were taken fresh from the soil, washed and dried and divided into two parts, and each part weighed. One part was analyzed at once and the other part treated as will be explained.

Experiment 1.

One hundred and fifty beets were dug up, and after washing, were divided into three "fifties." No. 1 "fifty" were weighed and analyzed directly. No. 2 were weighed and afterward laid out in the field under normal exposure. No. were packed in a tub with sand and soaked with water, also a large block of ice being laid upon the packed beets, which kept down the temperature, the water overflowing as the ice melted. The weights of the respective parts were identical, each "fifty" weighing exactly 41.5 pounds.

No. 1.—Analysis of Fresh Beets.

Number of Beets.	Brix. Per Cent.	Sucrose. Per Cent.
Mean of—		
10 Beets	19.9	15.0
10 Beets	19.3	14.6
10 Beets	20.7	15.8
10 Beets	19.5	19.0
10 Beets	19.7	14.8
Means	19.8	14.8

The mean purity was 74.2.

No. 2.—Analysis of Exposed Beets.

Number of Beets.	Brix. Per Cent.	Sucrose. Per Cent.
Mean of—		
10 Beets	23.4	18.9
10 Beets	23.6	19.9
10 Beets	22.5	15.9
10 Beets	22.6	16.7
10 Beets	22.5	16.0
Means	22.9	17.1

The mean purity was 73.7.

No. 3.—Analysis of Soaked Beets.

Number of Beets.	Brix. Per Cent.	Sucrose Per Cent.
Mean of—		
10 Beets	18.4	14.2
10 Beets	18.6	14.4
10 Beets	18.3	14.0
10 Beets	18.1	13.6
10 Beets	18.5	14.3
Means	18.3	14.1

The mean purity was 77.

The following tables present an analysis of the results of the three separate analyses:

FRESH BEETS.

First weight	pounds	41.5
Second weight	pounds	.....
Variation of weight	per cent.	.....
Brix	per cent.	19.8
Sucrose	per cent.	14.8
Content of sugar	pounds	6.14

EXPOSED BEETS.

First weight	pounds	41.5
Second weight	pounds	34.0
Variation of weight	per cent. loss	19.05
Brix	per cent.	22.9
Sucrose	per cent.	17.1
Content of sugar	pounds	5 08

SOAKED BEETS.

First weight	pounds	41.5
Second weight	pounds	44.0
Variation of weight	per cent. gain	6.02
Brix	per cent.	18.3
Sucrose	per cent.	14.1
Content of sugar	pounds	6 20

These data not only indicate the actual results, but also the ease with which the indications could be misunderstood. Although the exposed beets give a much higher polariscope reading, an actual loss of 6 per cent. of the total sugar had occurred. On the other hand the polariscope reading of the juices from the soaked beets was notably lower, yet those beets had more than maintained their sugar content. It may also be remarked that the moistened beets which had taken up 6.2 per cent. of their own weight of water gave a juice of much higher purity, being 3 per cent. higher than the fresh beets. In the polariscope tube the juices of the moistened beets read with great ease, whilst the others were difficult to read.

The results of the given experiments were not only satisfactory but they were striking, from the circumstance that a slight appreciation was observed in the sucrose content and a notable one in the purity. With such a result from placing the beets for 72 hours in soaked sand it was determined to experiment with a further number actually submerged in water.

Experiment 2.

One hundred beets were dug up, washed and divided into two identical parts. The first fifty were weighed and analyzed directly. The second fifty were weighed and placed in a tub of water, whose temperature was kept at 40 to 42 degrees by the addition of ice, the tub being placed in one of the silos. The submerged beets remained in the water for presisely seven days. When taken out they were dried and reweighed, and immediately analyzed. The following are the results:

No. 1.—Analysis of Fresh Beets.

Number of Beets.	Brix. Per Cent.	Sucrose. Per Cent.
Mean of—		
10 Beets	17.4	12.0
10 Beets	18.4	12.6
10 Beets	18.6	13.4
10 Beets	19.0	13.4
10 Beets	19.2	14.3
Means	18.5	13.1

The mean purity equals 70.8.

No. 2.—Analysis of Submerged Beets.

Number of Beets.	Brix. Per Cent.	Sacrose. Per Cent.
Mean of—		
10 Beets	16.4	12.7
10 Beets	16.7	13.1
10 Beets	16.4	12.8
10 Beets	16.6	13.1
10 Beets	16.5	13.0
Means	19.5	12.9

The mean purity equals 78.2.

Analytical Comparison of the Results.

Fresh Beets.

First weight	pounds	34.5
Second weight	pounds	.....
Variation of weight	per cent.	.....
Brix	per cent.	18.5
Sucrose	per cent.	13.1
Content of sugar	per cent.	4.51

Submerged Beets.

First weight	pounds	34.5
Second weight	pounds	40.0
Variation of weight	per cent. gain	15.9
Brix	per cent.	16.5
Sucrose	per cent.	12.9
Content of sugar	pounds	5.16

This table states that the submerged beets took up water during seven days' submersion to the extent of 15.9 per cent. of their weight, and that the actual sugar content was increased 14.2 per cent. In the first place, in consequence of the results obtained, I am obliged to reconsider an observation stated in my report of 1891, in which it is doubted that the beet can increase its sugar content after removal from the soil. These experiments indicate that such an increase has certainly occurred in beets under the conditions in which those examples under consideration were placed. The appreciation in the purity of the juices is also not less notable than the increase in the sucrose. The increment of weight was expected, and particularly considering the wilted condition in which the fresh beets were found. The results are extraordinary. They were, however, conducted with the most extreme care, every act of manipulation in the analysis being performed by me personally, which enables me to vouch for the greatest attainable accuracy.

At the time that the above experiment was completed the beets were suffering to a final degree from the influence of the dry soil and hot sun. A third experiment was made of the same nature as the two already tabulated, but the latter was carried out in the field. In a given plat of beets a certain row was selected, and a length of the row, including exactly 100 beets, was marked off. To those 100 beets 250 gallons of water were given, the loose soil raked up close to the beets to prevent the sun baking the moist surface, and the beets were left for seven days. At the end of that time those beets were dug up, washed, weighed and analyzed. At the same time 100 beets comprised within the same length of a parallel row, this row being separated from the watered row by five intervening rows, were taken up, washed, weighed and analyzed, and the following are the results:

Experiment 3.

Unwatered Beets.	Brix. Per Cent.	Sucrose. Per Cent.
Mean of—		
10 Beets	18.4	14.1
10 Beets	18.4	13.3
10 Beets	18.3	13.3
10 Beets	18.3	13.7
10 Beets	19.3	14.0
10 Beets	19 3	13.8
10 Beets	18.9	13.0
10 Beets	19.2	13.7
10 Beets	19.0	13.3
10 Beets	19.1	12.8
Means	18.9	13.5

The mean purity was 71.8.

Watered Beets.	Brix. Per Cent.	Sucrose. Per Cent.
Mean of—		
10 Beets	16.7	12.6
10 Beets	16.8	12.8
10 Beets	16.8	13.1
10 Beets	17.3	13.4
10 Beets	16.0	12.2
10 Beets	16.4	12.8
10 Beets	15.8	12.2
10 Beets	16.3	12.7
10 Beets	17.4	13.6
10 Beets	16.8	12.8
Means	16.6	12.8

The mean purity was 77.2.

COMPARISON OF THE RESULTS

Unwatered Beets.

Weight	pounds	78.5
Variation of weight	per cent.	.....
Brix	per cent.	18.8
Sucrose	per cent.	13.5
Content of Sugar	pounds	10.59

Watered Beets.

Weight	pounds	88.5
Variation of weight	per cent. gain	.....
Brix	per cent.	16.6
Sucrose	per cent.	12.8
Content of sugar	pounds	11.32

The experiment furnishes results identical with those obtained in the two preceding experiments. It must be observed, however, that in the last experiment the data are not as strictly comparative. The parallel rows from which each 100 beets were taken were exactly similar, but there may have been a small difference in the weight and sucrose content at the time the beets were watered. No difference, however, could have existed which would have amounted to even 10 per cent. of the difference found at the time of analysis. It is the most evident that the excessive quanity of water added to the 100 beets (250 gallons, which was 2½ gallons to each beet) not only caused a great increment of weight, but also an immediate formation of sugar, and the apprecation in the purity of the juices is very striking. In each of the experiments it is shown that the presence of excessive moisture raised the purity coefficient most notably, and in the last two experiments 7 and 8 points, respectively. This observation is strictly in accord with the general observations relating to the crops of each season since the station has been in operation. In 1891 the whole cultural season was very wet (see table of the climates for the three seasons), and at the time that the beets were harvested the ground was saturated with moisture, the rainfall for October of that year being four times greater than the normal. The crop of that season averaged 21.7 tons per acre; the average sucrose in the juice was 14.16 per cent., and the mean purity of all varieties was over 85. In 1892 the crop was notably lighter and the sucrose in the juice higher, owing to the dry season, but the mean purity was less than 80, the soil, mode of culture and the seed being the same.

In the series of special experiments conducted at the station results have been obtained which are more or less in direct opposition to certain accepted beliefs. Last year the experiments showed that not only no gain but an actual loss, and a very notable loss, of sugar occurs when beets are exposed to atmospheric influences after their removal from the soil, the special causes of that loss being strong sunlight and high temperature. Again, the results of experimentation during this year have indicated quite closely that, in an abnormal season, when the beets are depreciating in sugar content and quality under the influence of high temperature and a dried out soil, the depreciation can be checked and the conditions reversed by a timely application of water. Further, the observations of this year have shown that beets can be placed in soaked sand or even submerged in water at a given temperature for a term of seven days, and not only is there no depreciation found, but, with the increment of weight, an increase in the sugar content of the beet and a very notable appreciation in the purity of the juices are observed.

In placing the result of these experiments on record it is desirable and very appropriate that the views which stand in opposition to these results and the noteworthy authorities by whom those views have been held be kept in recollection. A revision of the theories which have been held in relation to the questions under discussion should only be considered when the data supporting some other view are sufficiently conclusive and important to make such revision imperative.

*BEET SUGAR PRODUCTION IN THE UNITED STATES IN THE YEARS 1891 AND 1892.

1891.

	Pounds.
Utah	1,094,900
California	8,175,438
Nebraska	2,734,500
Total	12,004,838

1892.

Utah:	
Utah Sugar Co., closed December 19, 1892	1,473,500
California:	
Alameda Sugar Co., closed December 8, 1892	2,506,860
Western Beet Sugar Co., closed January 27, 1893	11,390,921
Chino Valley Beet Sugar Co., closed Oct. 28, 1892	7,903,541
Nebraska:	
Oxnard Beet Sugar Co., Grand Island, closed November 19, 1892	2,110,100
Norfolk Beet Sugar Co., closed November 9, 1892	1,698,400
Total	28,083,322

This shows an increase of 125 per cent. in one year, and the increase was (estimated) about 100 per cent. in 1893 over 1892.

1893.

Staunton, Virginia	36,458
Grand Island, Nebraska	1,835,900
Lehi, Utah	3,750,000
Norfolk, Nebraska	4,000,000
Alvarado, Cal.	4,486,572
Watsonville, Cal	14,500,000
Chino, Cal	15,036,867

TOTAL CONSUMPTION OF SUGAR IN THE UNITED STATES.

	Tons.
1880	960,764
1885	1,298,380
1890	1,476,377
1891	1,888,851
1892	1,813,563

Willett & Gray make the total consumption as follows:

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*From Senator Peffer's Report on Agriculture and Agricultural Depression to the Senate Committee.

	Tons.
1890	1,522,731
1891	1,872,400
1892	1,837,626

INCREASE IN CONSUMPTION OF SUGAR IN THE UNITED STATES —PER CENTAGE AND PER CAPITA.

1883, 10 per cent. increase; 1884, 7 per cent. increase; 1885, nominal; 1886, 9 per cent. increase; 1887, 2.7 per cent. increase; 1888, 4.6 per cent increase; 1889, 1.2 per cent. decrease; 1890, 5.8 per cent. increase; 1891, 22.9 per cent. increase; 1892, 1.8 per cent. decrease.

The per capita consumption they give as follows:

	Pounds.		Pounds.
1885	49.9	1889	52.6
1886	52.5	1890	54.5
1887	52.1	1891	67.4
1888	54.2	1892	64.3

Commercial Agent Washburn, writing under date of March 30, 1892, says of the cost of producing the raw material for beet sugar:

"In estimating the various items of expense entering into the cultivation, the question of wages must be assigned a leading place. So important is it that many Germans of experience freely express the opinion that the relatively high rate of wages in the United States must effectually prevent the United States from ever being a dangerous competitor." Against this, however, are our cheaper lands. The wages in Europe vary, men receiving all the way from 45 cents to 85 cents a day, women from 30 to 60 cents, and children from 10 to 20 cents. He also notes that the employment of women and children makes the saving very considerable. He makes the cultivation abroad to cost 130 marks, or $49.50 per acre, while Licht makes it only $41.88; the average between the two would be $45.69. With this cost per acre abroad, the only way the German farmer gains an advantage at the lower price of beets there is in his superior cultivation, an increased tonnage and small wages paid.

Mr. E. H. Dyer, of the Alvarado factory in California, makes the cost per acre of beets $46, and profit to the farmer per acre $29, less land rent. The Utah Sugar Company at Lehi, Utah, makes the cost per acre $39, and the profit to the agriculturist $20.54. The Nebraska Department of Agriculture makes the average cost per acre $33, and profit about $67, with beets at $5 per ton, and the board cites the details of cost given by seven farmers where the average cost per acre was $44.85, and average profit per acre about $57. In these seven statements the gross return per acre is given at from $80 to $122, showing probably increased yield from superior cultivation, because the item of expense for cultivation is put down at a figure considerably beyond that given by the other six farmers. But the only way, with labor cost against them, in which our farmers make their showing so liberal is in the price ($5 per ton) they are paid for beets. Abroad the price runs from $3.50 to $4 only.

Among the very successful sugar beet farmers on the Chino ranch in California are the Gustafson brothers, Louis, Victor and Charles. The Gustafson brothers went to Chino three years ago without capital and commenced farming on their own account, doing their work thoroughly. They bought twenty acres of choice land west of Chino for $175 per acre, and on this they made the last payment last summer. They have paid for it from beets raised on the land.

They kept a careful itemized account of their expenses on the twenty acres of beets for 1893, including their own work, which they counted at $1.50 per day, and which amounted to $275. From twenty acres they harvested 436 tons, for which they received an average of $4.50 per ton. The figures are:

Gross returns, 436 tons		$1,962.00
Plowing 20 acres	$ 40.00	
Harrowing twice	12.00	
Seed	30.00	
Seeding	8.00	
Thinning	80.00	
Cultivating twice	12.00	
Weeding	20.00	
Topping	108.00	
Plowing out beets	40.00	
Hauling to factory	174.00	
Tare and factory expenses	60.20	
Total expenses	$ 584.60	
Net profit	1,377.40	
		$1,962.00
Net profits per acre		68.87

COST OF BEET SUGAR.

The cost of beet sugar to manufacturers in the United States differs, because it depends on the difference in cost of material and of labor, regard being had for location of factory, cost of freight, etc. Abroad the cost of producing beet sugar per ton or pound is from 25 to 50 per cent. less than it is here, and this is principally so because labor that costs here 75 cents and $1.50 a day can be obtained there for from 20 to 80 cents, and beets, for which $5 per ton are paid here, cost only $3.60 and $4 abroad. These two factories are the more material ones. For instance, in France the expenses on a ton of beets were as follows:

EXPENSES PER TON OF BEETS.

Bresles factory in France:	
Beets	$ 4.00
Coal	51
Coke and limestone	24
Labor	50
Lighting	03
Bone black	04
Commission on sales	09
Oil and grease	03
General expenses	16
Freights	08
Maintenance, repairs, insurance, etc. during idle season	80
	$ 6.45
Grand Island factory in Nebraska:	
Beets	$ 5.00
Coal	80
Coke	18
Limestone	15
Labor	1.57
Lighting	07
Oil and grease	04
Bags	20
Mechanical Filter bags	02
Mechanical filter cloths	04
Sundry operating expenses	17
Commission on sales	04
Discount	42
Freight of material	24
Maintenance and repair of factory during idle season of ten months in a year, with taves and insurance on same	1.87
	$10.81
Total, France	$ 6.45
Total, America	10.81

Average yield of sugar per ton of beets, 165 pounds; cost, per pound, 6 5-10 cents in Nebraska. Average selling price, 4½ cents.

In 1892 the actual cost of production in Nebraska, at Grand Island, was 6 cents; in 1891, 6½ cents; in 1890, 7 cents. Showing that in three years the cost of production has been reduced 1 cent per pound.

Reducing the cost of labor to what it is in France (50 cents), and the cost of beets to $4, the total expense on a ton of beets would be $10.81, minus $2.07, or $8.74. On this basis the cost of beet sugar here would be about 5½ cents per pound. The figures as to cost of beet sugar, as given by the Watsonville factory in 1888–'89, are as follows:

Freight to San Francisco	$ 2,936
Coal	17,267
Coke	1,658
Fuel oil	11,356
Wood	990
Lime rock	1,780
Sugar bags	1,740
Soda	12
Tallow	57
Expense, labor, etc	21,091
Incidentals	2,575
Beets, cost of	71,055
Total cost of 1,640 tons of sugar	$132,517
Received for it	162,454
Profit on 3,280,000 pounds	$ 29,937

This is about 5 per cent. on investment.

Sugar, average price, 5 6-10 cents. Paid for beets, average price, $5.

Consul J. S. Potter, writing on the subject of the cost of sugar in Germany, under date of 1880, says, it is about four cents per pound there. If allowance is made abroad for product from molasses, it is 3½ cents. Consul Potter's result is reached by making the beets yield 11 pounds of raw sugar from 110 pounds of beets, or 1 pound of sugar from 10 pounds of beets, or 200 pounds raw sugar from a short (2,000 pounds) ton of beets. He makes the cost of sugar 43 2-10 cents per 11 pounds of sugar, or about 4 cents per pound.

Other considerations are, that factories in the United States stand idle from six to nine months in a year, the capital invested being, for that period, a dead loss, while abroad they run from nine months to the year around. It results that a large amount of short-term labor here required is not utilized beyond a month or two, which causes labor to fix its own price in the United States.

Both here and abroad it is known that a beet-sugar factory, wherever located, will not pay the first two or three years, and a sinking fund is accordingly provided. At Grand Island, in Nebraska, about $90,000 was sunk the first two years. At Alvarado, Cal., Mr. Hecht tells us (see Hearings before Ways and Means Committee, September 19, 1893, p. 529) that the factory made no money on a $188,000 investment the first year, nor on a $556,000 investment the second year, only a reasonable dividend the third year.

If our beet sugar manufacturers could market their "by-products" as they do abroad, the cost of sugar here would be materially decreased. For instance, the beet pulp abroad is purchased and fed to cattle, because it is very fattening; worth there $1.25 a ton, given away here when 25 cents can not be obtained for it. Our farmers have not yet come to realize its full worth on the farm. Then we have the potash salts and the lime cake, used abroad by farmers for fertilizing and liberally paid for, while in this country it is an item of expense, as it must be hauled away from the factory. All these things enter into the question of the cost here of beet sugar under present conditions.

In Grant on Beet-Root Sugar p. 44, the author gives the cost of sugar in Franc at 4, 4 1-10 and 5 2-10 cents per pound, and his calculations is based on beets costing only $3.47, $3.87, and $3.80 cents per ton, and labor at only 66 to 70 cents a day.

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
1	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	*	15	21.10	15.46	73.21
2	Station Farm	Reno, Washoe county	Vilmorin's Improved	*	13	17.28	13.57	78.53
3	Station Farm	Reno, Washoe county	Vilmorin's Improved	*	11	18.40	16.00	86.09
4	Station Farm	Reno, Washoe county	Desprez	*	15	19.46	16.50	84.79
5	Station Farm	Reno, Washoe county	Desprez	*	13	17.32	13.47	77.77
6	Station Farm	Reno, Washoe county	Improved Klien Wanzlebener	*	6	18.91	15.22	79.42
7	Station Farm	Reno, Washoe county	Betterave a Collet Rouge	*	5	15.92	12.15	76.32
8	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	*	10	19.50	14.20	72.87
9	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	*	10	21.58	17.50	81.09
10	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	*	4	14.91	12.00	80.49
11	Orrin Ross	Reno, Washoe county	Dippe's Klein Wanzlebener	2	12	11.19	7.00	62.00
12	Orrin Ross	Reno, Washoe county	Dippe's Klein Wanzlebener	......	9	14.80	12.00	81.00
13	Orrin Ross	Reno, Washoe county	Vilmorin's Improved	1	14	14.25	12.00	84.00
14	Orrin Ross	Reno, Washoe county	Vilmorin's Improved	......	11	15.42	14.00	85.00
15	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	3	4	14.65	5.50	75.56
16	H H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	9	13.42	11.50	85.70
17	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	......	9	14.66	11.50	71.90
18	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	4	3	13.66	6.00	43.92
19	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	3	2	21.82	13.25	60.72
20	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	15	10.67	9.00	84.35
21	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebeher	......	12	18.04	15.25	84.53
22	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	1	14.99	12.10	80.73
23	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	3	4	16.08	14.75	91.74
24	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	2	13	13.25	12.30	92.84
25	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	3	14.12	11.20	81.17

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
26	H. H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	......	14	18.57	15.75	86.82
39	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	1	7	16.19	13.60	84.00
40	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	2	6	13.20	11.20	84.09
41	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	2	6	12.73	8.80	69.12
42	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	2	1	14.30	13.50	94.00
43	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	4	10	11.64	8.00	68.71
44	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	1	0	14.31	10.20	71.27
45	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	1	13	15.85	12.50	72.55
46	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	1	2	24.72	20.90	82.91
47	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	1	10	22.05	19.60	88.88
48	E. T. George	Lewis, Lander county	Vilmorin's Improved	1	2	23.04	20.20	87.63
49	E. T. George	Lewis, Lander county	Betterave a Collet Rouge	......	4	23.56	19.00	80.64
50	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	......	12	24.91	21.80	87.09
51	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	......	9	33.80	26.20	77.51
52	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	4	14	15.09	8.20	54.34
53	A. G. Brown	Brown's Station, Washoe county	Betterave a Collet Rouge	4	1	11.84	9.80	86.00
54	A. G. Brown	Brown's Station, Washoe county	Betterave a Collet Rouge	3	6	12.06	8.90	73.79
55	A. G. Brown	Brown's Station, Washoe county	Betterave a Collet Rouge	1	9	13.05	10.00	76.62
56	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	0	14.11	11.60	82.21
57	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	4	12.93	10.70	82.75
58	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	......	12	13.62	10.70	78.41
59	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	5	12.12	7.30	60.23
60	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	3	17.37	14.60	84.05
61	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	5	9.34	5.50	58.36
62	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	7	13.78	10.00	72.55
63	J. G. Young	Wabuska, Lyon cyunty	Verbesseter Klein Wanzlebener	2	12	14.14	10.60	74.96
64	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	2	1	13.71	11.50	83.87

65	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	12	13.15	10.70	80.68
66	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	2	12.43	8.60	69.18
67	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	6	6	9.43	8.00	84.83
68	M Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	8	13.66	9.70	71.01
69	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	4	13	12.97	8.80	67.80
70	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	6	14.03	10.20	72.70
71	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	4	14.59	10.20	69.99
72	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	1	4	13.53	10.00	73.99
73	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	1	5	10 80	7.80	72.22
74	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	11	16.26	12.40	76.38
75	G. W. Crumb	Battle Mountain, Lander county	Unknown	3	6	13.24	11.10	84.59
76	G. W. Crumb	Battle Mountain, Lander county	Unknown	2	3	15.28	12.10	79.18
77	G. W. Crumb	Battle Mountain, Lander county	Unknown	2	2	14.35	13.30	92.68
78	G. W. Crumb	Battle Mountain, Lander county	Unknown	1	13	15.32	13 40	87.46
79	G. W. Crumb	Battle Mountain, Lander county	Unknown	3	12	11.65	8.80	75.53
80	G W. Crumb	Battle Mountain, Lander county	Unknown	1	15	12.99	9.40	72 36
81	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener		7	19.77	17.50	88.51
82	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	0	18.49	15.20	81 99
83	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	2	6	13.36	11.90	89 07
84	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	2	2	13.73	10.50	76.40
85	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	6	14.99	10.00	66 63
86	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	3	12	12.85	11.40	88.72
87	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	3	5	15 03	12.30	81 82
88	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener		6	16.82	15.20	90.37
89	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	8	16.26	14.10	88.74
90	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	2	7	16.19	12.50	77.20
91	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	6	7	12.77	7.90	61.86
92	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	5	3	10 79	7.60	70.43
93	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	6	13	12.50	9.00	72.00
94	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	7	8	18.64	6.30	33.97
95	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	3	12	15.43	13.60	88.13
96	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener		14	22.84	17.50	76.66
97	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener	1	6	17.29	14.70	85.01
98	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener		12	17.58	15.40	87.03
89	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	2	6	19.71	17.00	86.26
100	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener		8	26.47	22.50	85.31

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
26	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener		14	18.57	15.75	86.82
39	Station Farm	Reno, Washoe county	Improved Klein Wanzlebener	1	7	16.19	13.60	84.00
40	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	2	6	13.20	11.20	84.09
41	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	2	6	12.73	8.80	69.12
42	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	2	1	14.30	13.50	94.00
43	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	4	10	11.64	8.00	68.71
44	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	1	0	14.31	10.20	71.27
45	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	1	13	15.85	12.50	72.55
46	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener	1	2	24.72	20.90	82.91
47	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	1	10	22.05	19.60	88.88
48	E. T. George	Lewis, Lander county	Vilmorin's Improved	1	2	23.04	20.20	87.63
49	E. T. George	Lewis, Lander county	Betterave a Collet Rouge		4	23.56	19.00	80.64
50	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener		12	24.91	21.80	87.09
51	E. T. George	Lewis, Lander county	Verbesseter Klein Wanzlebener		9	33.80	26.20	77.51
52	E. T. George	Lewis, Lander county	Dippe's Klein Wanzlebener	4	14	15.09	8.20	54.34
53	A. G. Brown	Brown's Station, Washoe county	Betterave a Collet Rouge	4	1	11.84	9.80	86.00
54	A. G. Brown	Brown's Station, Washoe county	Betterave a Collet Rouge	3	6	12.06	8.90	73.79
55	A. G. Brown	Brown's Station, Washoe county	Betterave a Collet Rouge	1	9	13.05	10.00	76.62
56	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	0	14.11	11.60	82.21
57	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	4	12.93	10.70	82.75
58	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge		12	13.62	10.70	78.41
59	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	5	12.12	7.30	60.23
60	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	3	17.37	14.60	84.05
61	E. E. Crane	Steamboat Springs, Washoe Co.	Betterave a Collet Rouge	1	5	9.34	5.50	58.36
62	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	7	13.78	10.00	72.55
68	J. G. Young	Wabuska, Lyon cyunty	Verbesseter Klein Wanzlebener	2	12	14.14	10.60	74.96
64	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	2	1	13.71	11.50	83.87

65	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	12	13.15	10.70	80.68
66	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	2	12.43	8.60	69.18
67	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	6	6	9.43	8.00	84.83
68	M Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	8	13.66	9.70	71.01
69	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	4	13	12.97	8.80	67.80
70	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	6	14.03	10.20	72.70
71	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	4	14.59	10.20	69.99
72	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	1	4	13.53	10.00	73.99
73	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	1	5	10 80	7.80	72.22
74	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	11	16.26	12.40	76.38
75	G. W. Crumb	Battle Mountain, Lander county	Unknown	3	6	13.24	11.10	84.59
76	G. W. Crumb	Battle Mountain, Lander county	Unknown	2	3	15.28	12.10	79.18
77	G. W. Crumb	Battle Mountain, Lander county	Unknown	2	2	14.35	13.30	92.68
78	G. W. Crumb	Battle Mountain, Lander county	Unknown	1	13	15.32	13 40	87.46
79	G. W. Crumb	Battle Mountain, Lander county	Unknown	3	12	11.65	8.80	75.53
80	G W. Crumb	Battle Mountain, Lander county	Unknown	1	15	12.99	9.40	72 36
81	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener		7	19.77	17.50	88.51
82	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	0	18.49	15.20	81.99
83	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	2	6	13.36	11.90	89 07
84	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	2	2	13.73	10.50	76.40
85	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	6	14.99	10.00	66.63
86	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	3	12	12.85	11.40	88.72
87	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	3	5	15 03	12.30	81 82
88	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener		6	16.82	15.20	90.37
89	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	8	16.26	14.10	88.74
90	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	2	7	16.19	12.50	77.20
91	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	6	7	12.77	7.90	61.86
92	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	5	3	10.79	7.60	70.43
93	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	6	13	12.50	9.00	72.00
94	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	7	8	18.64	6.30	33.97
95	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	3	12	15.43	13.60	88.13
96	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener		14	22.84	17.50	76.66
97	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener	1	6	17.29	14.70	85.01
98	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener		12	17.58	15.40	87.03
89	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	2	6	19.71	17.00	86.26
100	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener		8	26.47	22.50	85.31

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
101	Station Farm	Reno, Nev	Dippe's Klien Wanzlebener	....	8	27.40	23.80	86.86
102	Robt. Eason	Reno, Nev	Betterave a Collet Rouge	1	12	12.88	11.10	86.97
103	Robt Eason	Reno, Nev	Betterave a Collet Rouge	1	12	14.35	12.30	85.71
104	Robt. Eason	Reno, Nev	Betterave a Collet Rouge	1	15	16.99	13.90	81.81
105	Robt. Eason	Reno, Nev	Betterave a Collet Rouge	1	7	17.58	14.20	80.77
106	Louis Dutertre	Golconda, Humboldt county	Unknown	3	12	14.90	9.90	60.40
107	Louis Dutertre	Golconda, Humboldt county	Unknown	2	14	11.24	8.00	71.17
108	Louis Dutertre	Golconda, Humboldt county	Unknown	2	......	14.00	13.00	84.57
109	Louis Dutertre	Golconda, Humboldt county	Unknown	1	12	14.53	12.50	83.27
110	Louis Dutertre	Golconda, Humboldt county	Unknown	1	2	15.65	11.60	77.07
111	Louis Dutertre	Golconda, Humboldt county	Unknown	1	5	15.58	13.20	84.85
112	Louis Dutertre	Golconda, Humboldt county	Unknown	1	5	17.52	15.00	83.35
113	Louis Dutertre	Golconda, Humboldt county	Unknown	1	2	20.44	18.60	90.95
114	Station Farm	Reno, Nev	Vilmorin's Improved	2	1	16.42	15.10	96.38
115	Station Farm	Reno, Nev	Vilmorin's Improved	1	4	19.39	17.40	89.76
116	Station Farm	Reno, Nev	Vilmorin's Improved	1	3	20.08	18.50	92.22
117	Station Farm	Reno, Nev	Vilmorin's Improved	......	13	19.77	18.90	93.42
118	Station Farm	Reno, Nev	Vilmorin's Improved	......	9	19.88	17.40	87.53
119	Station Farm	Reno, Nev	Vilmorin's Improved	......	8	21.89	20.10	91.83
120	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	1	4	19.59	17.20	87.59
121	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	1	4	19.63	18.20	92.73
122	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	......	14	19.02	17.30	93.08
123	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	......	12	21.46	20.20	94.13
124	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	....	9	21.17	20.50	96.82
125	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	......	6	21.14	19.50	92.56
126	Station Farm	Reno, Nev	Betterave a Collet Rouge	......	12	17.21	16.40	97.55
127	Station Farm	Reno, Nev	Betterave a Collet Rough	......	11	17.91	14.20	79.31

128	Station Farm	Reno, Nevada	Betterave a Collet Rouge		9	14.64	12.80	87.67
129	Station Farm	Reno, Nevada	Betterave a Collet Rouge		15	15.76	13.90	88.02
130	Station Farm	Reno, Nevada	Betterave a Collet Rouge		10	17.20	14.90	86.62
131	Station Farm	Reno, Nevada	Betterave a Collet Rouge		8	17.54	16.30	92.93
132	Station Farm	Reno, Nevada	Desprez		9	20.98	18.50	88.19
133	Station Farm	Reno, Nevada	Desprez		14	22.48	21.60	96.12
134	Station Farm	Reno, Nevada	Desprez		14	22.68	21.90	94.36
135	Station Farm	Reno, Nevada	Desprez		9	22.51	20.80	95.55
136	Station Farm	Reno, Nevada	Desprez		8	22.68	21.20	93.47
137	Station Farm	Reno, Nevada	Desprez		9	22.12	21.20	95.87
138	Station Farm	Reno, Nevada	Desprez		10	23.60	22.00	94.07
139	Station Farm	Reno, Nevada	Desprez		12	22.37	18.60	85.07
140	Station Farm	Reno, Nevada	Desprez		14	22.16	21.10	95.26
141	Station Farm	Reno, Nevada	Desprez		10	23.65	18.20	76.97
142	Station Farm	Reno, Nevada	Desprez		8	23.87	21.90	91.72
143	Station Farm	Reno, Nevada	Desprez		5	22.30	21.40	98.19
144	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener	1	9	23.51	17.30	74.00
145	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener		14	26.80	21.10	79.04
146	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener		3	24.22	22.60	92.96
147	F. Dangberg	Genoa, Douglas county		3	1	15.80	13.20	83.53
148	F. Dangberg	Genoa, Douglas county		2	3	14.11	13.70	97.08
149	F. Dangberg	Genoa, Douglas county		1	14	12.83	12.60	95.83
150	Station Farm	Reno, Nevada	Betterave a Collet Rouge		15	16.78	16.30	97.10
151	Station Farm	Reno, Nevada	Betterave a Collet Rouge		14	15.92	14.90	93.59
152	Station Farm	Reno, Nevada	Betterave a Collet Rouge		8	18.70	16.60	88.85
153	Station Farm	Reno, Nevada	Betterave a Collet Rouge		9	19.52	17.90	91.49
154	Station Farm	Reno, Nevada	Desprez	1	2	20.78	19.90	95.75
155	Station Farm	Reno, Nevada	Desprez	1	1	18.44	16.40	88.94
156	Station Farm	Reno, Nevada	Desprez		13	22.10	19.10	86.41
157	Station Farm	Reno, Nevada	Desprez		11	23.20	20.80	87.61
158	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8	16.94	15.90	98.34
159	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		6	13.89	12.70	91.53
160	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		5	17.35	15.60	71.41
161	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		6	19.24	16.10	81.77
162	D. H. Dillard	St. Clair, Churchill county	Desprez		12	17.64	16.30	92.41
163	D. H. Dillard	St. Clair, Churchill county	Desprez		7	21.88	17.80	81.25

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
164	D. H. Dillard	St. Clair, Churchill county	Desprez		9	19.74	14.90	75.47
165	D. H. Dillard	St. Clair, Churchill county	Desprez		10	17.15	15.40	71.16
166	D. H. Dillard	St. Clair, Churchill county	Desprez		10	20.60	16.10	78.13
167	D. H. Dillard	St. Clair, Churchill county	Desprez		12	20.05	17.10	85.24
168	D. H. Dillard	St. Clair, Churchill county	Desprez		14	19.29	17.10	91.17
169	D. H. Dillard	St. Clair, Churchill county	Desprez		9	19 55	17 20	87.97
170	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	12	14.25	13.10	92.11
171	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener		13	17.17	15.80	91.99
172	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	1	16.05	15.70	97.82
173	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	7	16.86	15.50	91 95
174	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klien Wanzlebener	3	12	23.15	10.20	44.05
175	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	4	2	16.93	11.90	73 61
176	H.H. Springmeyer	Gardnerville, Douglas conuty	Improved Klein Wanzlebener	2	2	15 90	10.70	67.27
177	F. Dangberg	Genoa, Douglas county		4	10	10.18	8.10	79.56
178	F. Dangberg	Genoa, Douglas county		1	2	14.66	12 10	82.55
179	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	3	2	14.96	11.80	78.88
180	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	2	12	17.90	8.90	49.60
181	J. W. Haines	Genoa, Douglas county			5	25.45	21 80	85.64
182	J. W. Haines	Genoa, Douglas county			3	24.17	21 00	87.43
183	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1		19.26	18.00	93.40
184	Station Farm	Reno. Nevada	Improved Klein Wanzlebener	1	8	20.09	17.90	89.09
185	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	2	21.19	15.90	75.03
186	Station Farm	Reno, Nevada	Improved Klein Wanzlebeher		13	19.97	16.70	83.62
187	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8	21.76	17 10	78.58
188	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8	23 22	21.70	93.43
189	Station Farm	Reno, Nevada	Unknown red beet		6	23 86	22.00	92 23
190	Station Farm	Reno, Nevada	Dippe's Klein Wanzlebener		15	23.29	21 00	88.13

191	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	1	7	18.35	16.90	92.09
192	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	......	13	22.72	17 60	77.46
193	John Harrison	Lovelocks, Humboldt county	Unknown	1	2	22.24	18.10	81.37
194	John Harrison	Lovelocks, Humboldt county	Unknown	1	7	18.19	15.90	87.37
195	John Harrison	Lovelocks, Humboldt county	Unknown	......	8	22.59	21.10	94 26
196	John Harrison	Lovelocks, Humboldt county	Unknown	......	11	21.66	19.90	91.45
197	Station Farm	Reno, Nevada	Desprez	2	12	19.80	17.20	86.88
198	Station Farm	Reno, Nevada	Desprez	2	14	20.02	17 60	87.91
199	Station Farm	Reno, Nevada	Dippe's Klein Wanzlebener	1	8	21.95	20 10	91.56
200	Station Farm	Reno, Nevada	Desprez	1	11	24 25	21 10	87 03
201	Station Farm	Reno, Nevada	Dippe's Klein Wanzlebener	1	3	22.15	20.10	90.75
202	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	2	7	19.30	9.00	46.63
203	A. Litch	Reno Nevada	Verbesseter Klein Wanzlebener	1	12	14.91	13.00	87.19
204	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	1	11	14.40	13 50	93.75
205	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	1	......	15.38	14.00	91.02
206	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	......	15	15.26	14.50	94.94
207	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	......	9	16 98	15.25	89.81
208	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	......	9	23.21	16.90	72.85
209	Orrin Ross	Reno, Nevada	Dippe's Klein Wanzlebener	2	5	12.60	10.75	85.33
210	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	......	12	20.34	11.10	54.57
211	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	1	8	11.41	8.20	71.87
212	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	......	15	12.62	10.50	83.20
213	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	10	4	7.87	2.10	29.26
214	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	6	14	9.45	3.30	34 92
215	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	5	3	10.79	8.90	82.48
216	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	2	1	5.51	4.20	76.25
217	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	2	4	6.24	5 20	83.31
218	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	2	1	5.63	4.10	71.11
219	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	......	6	15.30	12.00	76.64
220	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	2	7	13.60	10.30	75.73
221	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	2	4	13.40	10.30	76.86
222	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	1	4	14.20	11.90	81.70
301	Station Farm	Reno, Nevada	Vilmorin	......	$10\frac{3}{4}$	15.50	10 20	64 61
302	Station Farm	Reno, Nevada	Simon Le Grande	......	$16\frac{3}{4}$	15.30	10.30	67 31
303	Station Farm	Reno, Nevada	Vilmorin Amelioree	......	$7\frac{1}{2}$	....	14.96	....
304	Station Farm	Reno, Nevada	Vilmorin Amelioree	......	$13\frac{3}{8}$	15.80	12.50	79 10

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
26	H. H. Springmeyer	Gardnerville, Douglas county.....	Improved Klein Wanzlebener..	......	14	18.57	15.75	86.82
39	Station Farm....	Reno, Washoe county............	Improved Klein Wanzlebener..	1	7	16.19	13.60	84.00
40	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	2	6	13.20	11.20	84.09
41	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	2	6	12.73	8.80	69.12
42	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	2	1	14.30	13.50	94.00
43	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	4	10	11.64	8.00	68.71
44	E. T. George......	Lewis, Lander county............	Verbesseter Klein Wanzlebener	1	0	14.31	10.20	71.27
45	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	1	13	15.85	12.50	72.55
46	E. T. George......	Lewis, Lander county............	Verbesseter Klein Wanzlebener	1	2	24.72	20.90	82.91
47	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	1	10	22.05	19.60	88.88
48	E. T. George......	Lewis, Lander county............	Vilmorin's Improved...........	1	2	23.04	20.20	87.63
49	E. T. George......	Lewis, Lander county............	Betterave a Collet Rouge.......	......	4	23.56	19.00	80.64
50	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	......	12	24.91	21.80	87.09
51	E. T. George......	Lewis, Lander county............	Verbesseter Klein Wanzlebener	......	9	33.80	26.20	77.51
52	E. T. George......	Lewis, Lander county............	Dippe's Klein Wanzlebener....	4	14	15.09	8.20	54.34
53	A. G. Brown......	Brown's Station, Washoe county..	Betterave a Collet Rouge.......	4	1	11.84	9.80	86.09
54	A. G. Brown......	Brown's Station, Washoe county..	Betterave a Collet Rouge.......	3	6	12.06	8.90	73.79
55	A. G. Brown......	Brown's Station, Washoe county.	Betterave a Collet Rouge.......	1	9	13.05	10.00	76.62
56	E. E. Crane......	Steamboat Springs, Washoe Co...	Betterave a Collet Rouge.......	1	0	14.11	11.60	82.21
57	E. E. Crane......	Steamboat Springs, Washoe Co...	Betterave a Collet Rouge.......	1	4	12.93	10.70	82.75
58	E. E. Crane......	Steamboat Springs, Washoe Co...	Betterave a Collet Rouge.......	......	12	13.62	10.70	78.41
59	E. E. Crane......	Steamboat Springs, Washoe Co...	Betterave a Collet Rouge.......	1	5	12.12	7.30	60.23
60	E. E. Crane......	Steamboat Springs, Washoe Co...	Betterave a Collet Rouge.......	1	3	17.37	14.60	84.05
61	E. E. Crane......	Steamboat Springs, Washoe Co...	Betterave a Collet Rouge.......	1	5	9.34	5.50	58.86
62	J. G. Young......	Wabuska, Lyon county..........	Verbesseter Klein Wanzlebener	1	7	13.78	10.00	72.55
63	J. G. Young......	Wabuska, Lyon cyunty..........	Verbesseter Klein Wanzlebener	2	12	14.14	10.60	74.96
64	J. G. Young......	Wabuska, Lyon county..........	Verbesseter Klein Wanzlebener	2	1	13.71	11.50	83.87

65	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	12	13.15	10.70	80.68
66	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	2	12.43	8.60	69.18
67	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	6	6	9.43	8.00	84.83
68	M Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	8	13.66	9.70	71.01
69	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	4	13	12.97	8.80	67.80
70	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	6	14.03	10.20	72.70
71	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	4	14.59	10.20	69.99
72	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	1	4	13.53	10.00	73.99
73	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	1	5	10 80	7.80	72.22
74	M. Cohn	Genoa, Douglas county	Improved Klein Wanzlebener	2	11	16.26	12.40	76.38
75	G. W. Crumb	Battle Mountain, Lander county	Unknown	3	6	13.24	11.10	84.59
76	G. W. Crumb	Battle Mountain, Lander county	Unknown	2	3	15.28	12.10	79.18
77	G. W. Crumb	Battle Mountain, Lander county	Unknown	2	2	14.35	13.30	92.68
78	G. W. Crumb	Battle Mountain, Lander county	Unknown	1	13	15.32	13 40	87.46
79	G. W. Crumb	Battle Mountain, Lander county	Unknown	3	12	11.65	8.80	75.53
80	G W. Crumb	Battle Mountain, Lander county	Unknown	1	15	12.99	9.40	72 36
81	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener		7	19.77	17 50	88.51
82	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebenor	1	0	18.49	15.20	81.99
83	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	2	6	13.36	11.90	89.07
84	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	2	2	13.73	10.50	76.40
85	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	6	14.99	10.00	66.63
86	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	3	12	12.85	11.40	88.72
87	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	3	5	15 03	12.30	81 82
88	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener		6	16.82	15.20	90.37
89	D. C. Simpson	Wellington, Lyon county	Improved Klein Wanzlebener	1	8	16.26	14.10	88.74
90	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	2	7	16.19	12.50	77 20
91	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	6	7	12.77	7.90	61.86
92	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	5	3	10.79	7.60	70.43
93	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	6	13	12.50	9.00	72.00
94	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	7	8	18.64	6.30	33 97
95	Charles Ross	Mason Valley, Lyon county	Verbesseter Klein Wanzlebener	3	12	15.43	13 60	88.13
96	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener		14	22.84	17.50	76.66
97	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener	1	6	17.29	14.70	85.01
98	R. Lewers	Franktown, Washoe county	Verbesseter Klein Wanzlebener		12	17.58	15.40	87.03
89	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener	2	6	19.71	17.00	86.26
100	Station Farm	Reno, Washoe county	Dippe's Klein Wanzlebener		8	26.47	22.50	85.31

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
101	Station Farm	Reno, Nev	Dippe's Klien Wanzlebener		8	27.40	23.80	86.86
102	Robt. Eason	Reno, Nev	Betterave a Collet Rouge	1	12	12.88	11.10	86.97
103	Robt Eason	Reno, Nev	Betterave a Collet Rouge	1	12	14.35	12.30	85.71
104	Robt. Eason	Reno, Nev	Betterave a Collet Rouge	1	15	16.99	13.90	81.81
105	Robt. Eason	Reno, Nev	Betterave a Collet Rouge	1	7	17.58	14.20	80.77
106	Louis Dutertre	Golconda, Humboldt county	Unknown	3	12	14.90	9.90	60.40
107	Louis Dutertre	Golconda, Humboldt county	Unknown	2	14	11.24	8.00	71.17
108	Louis Dutertre	Golconda, Humboldt county	Unknown	2		14.00	13.00	84.57
109	Louis Dutertre	Golconda, Humboldt county	Unknown	1	12	14.53	12.50	83.27
110	Louis Dutertre	Golconda, Humboldt county	Unknown	1	2	15.05	11.60	77.07
111	Louis Dutertre	Golconda, Humboldt county	Unknown	1	5	15.58	13.20	84.85
112	Louis Dutertre	Golconda, Humboldt county	Unknown	1	5	17.52	15.00	83.35
113	Louis Dutertre	Golconda, Humboldt county	Unknown	1	2	20.44	18.60	90.95
114	Station Farm	Reno, Nev	Vilmorin's Improved	2	1	16.42	15.10	96.28
115	Station Farm	Reno, Nev	Vilmorin's Improved	1	4	19.39	17.40	89.76
116	Station Farm	Reno, Nev	Vilmorin's Improved	1	3	20.08	18.50	92.22
117	Station Farm	Reno, Nev	Vilmorin's Improved		13	19.77	18.90	93.42
118	Station Farm	Reno, Nev	Vilmorin's Improved		9	19.88	17.40	87.53
119	Station Farm	Reno, Nev	Vilmorin's Improved		8	21.89	20.10	91.83
120	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	1	4	19.59	17.20	87.59
121	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener	1	4	19.63	18.20	92.73
122	Station Farm	Reno, Nev	Dipre's Klein Wanzlebener		14	19.02	17.30	93.08
123	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener		12	21.46	20.20	94.13
124	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener		9	21.17	20.50	96.82
125	Station Farm	Reno, Nev	Dippe's Klein Wanzlebener		6	21.14	19.50	92.56
126	Station Farm	Reno, Nev	Betterave a Collet Rouge		12	17.21	16.40	97.55
127	Station Farm	Reno, Nev	Betterave a Collet Rough		11	17.91	14.20	79.31

128	Station Farm	Reno, Nevada	Betterave a Collet Rouge		9	14.64	12.80	87.67
129	Station Farm	Reno, Nevada	Betterave a Collet Rouge		15	15.76	13.90	88.02
130	Station Farm	Reno, Nevada	Betterave a Collet Rouge		10	17.20	14.90	86.62
131	Station Farm	Reno, Nevada	Betterave a Collet Rouge		8	17.54	16.30	92.93
132	Station Farm	Reno, Nevada	Desprez		9	20.98	18.50	88.19
133	Station Farm	Reno, Nevada	Desprez		14	22.48	21 60	96.12
134	Station Farm	Reno, Nevada	Desprez		14	22.68	21.90	94.36
135	Station Farm	Reno, Nevada	Desprez		9	22.51	20.80	95 55
136	Station Farm	Reno, Nevada	Desprez		8	22.68	21.20	93.47
137	Station Farm	Reno, Nevada	Desprez		9	22.12	21.20	95.87
138	Station Farm	Reno, Nevada	Desprez		10	23.60	22.00	94.07
139	Station Farm	Reno, Nevada	Desprez		12	22 37	18.60	85.07
140	Station Farm	Reno, Nevada	Desprez		14	22 16	21.10	95.26
141	Station Farm	Reno, Nevada	Desprez		10	23.65	18.20	76.97
142	Station Farm	Reno, Nevada	Desprez		8	23.87	21.90	91.72
143	Station Farm	Reno, Nevada	Desprez		5	22.30	21.40	98.19
144	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener	1	9	23.51	17.30	74.00
145	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener		14	26.80	21.10	79.04
146	H. H. Coryell	Wells, Elko county	Verbesseter Klein Wanzlebener		3	24.22	22.60	92.96
147	F. Dangberg	Genoa, Douglas county		3	1	15.80	13.20	83.53
148	F. Dangberg	Genoa, Douglas county		2	3	14 11	13.70	97.08
149	F. Dangberg	Genoa, Douglas county		1	14	12.83	12.60	95.83
150	Station Farm	Reno, Nevada	Betterave a Collet Rouge		15	16.78	16.30	97.10
151	Station Farm	Reno, Nevada	Betterave a Collet Rouge		14	15.92	14.90	93.59
152	Station Farm	Reno, Nevada	Betterave a Collet Rouge		8	18.70	16.60	88.85
153	Station Farm	Reno, Nevada	Betterave a Collet Rouge		9	19.52	17.90	91.49
154	Station Farm	Reno, Nevada	Desprez	1	2	20.78	19.90	95.75
155	Station Farm	Reno, Nevada	Desprez	1	1	18.44	16.40	88.94
156	Station Farm	Reno, Nevada	Desprez		13	22.10	19 10	86.41
157	Station Farm	Reno, Nevada	Desprez		11	23.20	20.80	87.61
158	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8	16.94	15.90	98.34
159	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		6	13.89	12 70	91.53
160	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		5	17.35	15.60	71.41
161	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		6	19.24	16.10	81.77
162	D. H. Dillard	St. Clair, Churchill county	Desprez		12	17.64	16.30	92.41
163	D. H. Dillard	St. Clair, Churchill county	Desprez		7	21.88	17 80	81.25

Table Showing General Summary of All Analyses for the Years 1891–92.—*Continued.*

Station No.	Grower.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
164	D. H. Dillard	St. Clair, Churchill county	Desprez		9	19.74	14.90	75.47
165	D. H. Dillard	St. Clair, Churchill county	Desprez		10	17.15	15.40	71.16
166	D. H. Dillard	St. Clair, Churchill county	Desprez		10	20.60	16.10	78.13
167	D. H. Dillard	St. Clair, Churchill county	Desprez		12	20.65	17.10	85.24
168	D. H. Dillard	St. Clair, Churchill county	Desprez		14	19.29	17.10	91.17
169	D. H. Dillard	St. Clair, Churchill county	Desprez		9	19.55	17.20	87.97
170	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	12	14.25	13.10	92.11
171	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener		13	17.17	15.80	91.99
172	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	1	16.05	15.70	97.82
173	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	1	7	16.86	15.50	91.95
174	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klien Wanzlebener	3	12	23.15	10.20	44.05
175	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	4	2	16.93	11.90	73.61
176	H.H. Springmeyer	Gardnerville, Douglas county	Improved Klein Wanzlebener	2	2	15.90	10.70	67.27
177	F. Dangberg	Genoa, Douglas county		4	10	10.18	8.10	79.56
178	F. Dangberg	Genoa, Douglas county		1	2	14.66	12.10	82.55
179	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	3	2	14.96	11.80	78.88
180	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	2	12	17.90	8.90	49.60
181	J. W. Haines	Genoa, Douglas county			5	25.45	21.80	85.64
182	J. W. Haines	Genoa, Douglas county			3	24.17	21.00	87.43
183	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1		19.26	18.00	93.40
184	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	8	20.09	17.90	89.09
185	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	2	21.19	15.90	75.03
186	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		13	19.97	16.70	83.62
187	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8	21.76	17.10	78.58
188	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8	23.22	21.70	93.43
189	Station Farm	Reno, Nevada	Unknown red beet		6	23.86	22.00	92.23
190	Station Farm	Reno, Nevada	Dippe's Klein Wanzlebener		15	23.29	21.00	88.13

191	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	1	7	18.35	16.90	92.09
192	S. J. Bryant	Reno, Nevada	Betterave a Collet Rouge	......	13	22.72	17 60	77.46
193	John Harrison	Lovelocks, Humboldt county	Unknown	1	2	22.24	18.10	81.37
194	John Harrison	Lovelocks, Humboldt county	Unknown	1	7	18.19	15.90	87.37
195	John Harrison	Lovelocks, Humboldt county	Unknown	......	8	22.59	21.10	94.26
196	John Harrison	Lovelocks, Humboldt county	Unknown	......	11	21.66	19.90	91.45
197	Station Farm	Reno, Nevada	Desprez	2	12	19.80	17.20	86.88
198	Station Farm	Reno, Nevada	Desprez	2	14	20.02	17.60	87.91
199	Station Farm	Reno, Nevada	Dippe's Klein Wanzlebener	1	8	21.95	20.10	91.56
200	Station Farm	Reno, Nevada	Desprez	1	11	24.25	21 10	87 03
201	Station Farm	Reno, Nevada	Dippe's Klein Wanzlebener	1	3	22.15	20.10	90.75
202	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	2	7	19.30	9.00	46.63
203	A. Litch	Reno Nevada	Verbesseter Klein Wanzlebener	1	12	14.91	13.00	87.19
204	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	1	11	14.40	13 50	93.75
205	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	1	......	15.38	14.00	91.02
206	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	......	15	15.26	14.50	94.94
207	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	......	9	16 98	15.25	89.81
208	A. Litch	Reno, Nevada	Verbesseter Klein Wanzlebener	......	9	23.21	16.90	72.85
209	Orrin Ross	Reno, Nevada	Dippe's Klein Wanzlebener	2	5	12.60	10 75	85.33
210	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	......	12	20.34	11.10	54.57
211	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	1	8	11.41	8.20	71.87
212	W. R. James	Virginia City, Storey county	Verbesseter Klein Wanzlebener	......	15	12.62	10.50	83.20
213	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	10	4	7.87	2.10	29.26
214	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	6	14	9.45	3.30	34 92
215	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	5	3	10.79	8.90	82.48
216	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	2	1	5.51	4.20	76.25
217	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	2	4	6.24	5 20	83.31
218	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	2	1	5.63	4.10	71.11
219	O. J. Douglas	Reno, Nevada	Verbesseter Klein Wanzlebener	......	6	15.30	12.00	76.64
220	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	2	7	13.60	10.30	75.73
221	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	2	4	13.40	10.30	76.86
222	Mrs. S. Frost	White Rock, Elko county	Verbesseter Klein Wanzlebener	1	4	14.20	11.90	81.70
301	Station Farm	Reno, Nevada	Vilmorin	......	10¾	15.50	10.20	64 61
302	Station Farm	Reno, Nevada	Simon Le Grande	......	16¾	15.30	10.30	67 31
303	Station Farm	Reno, Nevada	Vilmorin Amelioree	......	7½	....	14.96	....
304	Station Farm	Reno, Nevada	Vilmorin Amelioree	......	13⅜	15.80	12.50	79 10

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet		Per Cent. of total solids.	Per Cent. of Sucrose.	Purity.
				Lbs.	Ozs.			
305	Station Farm	Reno, Nevada	Vilmorin Amelioree	1	3.75	16.80	13.80	82.62
306	Station Farm	Reno, Nevada	Desprez		4.50	16 80	13.20	78.57
307	Station Farm	Reno, Nevada	Desprez	1	7.25	16.80	13.20	78.57
308	Station Farm	Reno. Nevada	Desprez		8	16.80	13.20	78.57
309	Station Farm	Reno, Nevada	Florimond Desprez	1	5 1–16	15.60	13.00	83.34
310	Station Farm	Reno, Nevada	Florimond Desprez		5⅝	15.60	13.00	83.34
311	Station Farm	Reno, Nevada	Florimond Desprez		9⅞	15.60	13.00	83.34
312	Station Farm	Reno, Nevada	Klein Wanzlebener		10½	18.20	16.40	90.10
313	Station Farm	Reno, Nevada	Klein Wanzlebener	1	1⅞	18.20	16.40	90.10
314	Station Farm	Reno, Nevada	Klien Wanzlebener	1	1 11–16	18.20	16.40	90.10
315	Station Farm	Reno, Nevada	Improved Vilmorin		9¼	17.40	14.80	85.08
316	Station Farm	Reno, Nevada	Improved Vilmorin		4½	17.40	14.80	85.08
317	Station Farm	Reno, Nevada	Improved Vilmorin		1 5–16	17.40	14.80	85.08
318	Station Farm	Reno, Nevada	Improved Vilmorin		15¼	17.40	14.80	85.08
319	Station Farm	Reno, Nevada	Simon Le Grande		10⅞	18.30	16 10	87.97
320	Station Farm	Reno, Nevada	Simon Le Grande		9¼	18.30	16.10	87.97
321	Station Farm	Reno, Nevada	Simon Le Grande		6 13–16	18.30	16.10	87.97
322	Station Farm	Reno, Nevada	Desprez		15	17.10	14.50	85.00
323	Station Farm	Reno, Nevada	Desprez		6 3–16	17.10	14.50	85.00
324	Station Farm	Reno, Nevada	Desprez		5½	17 10	14 50	85.00
325	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		4½	18.00	15.80	87.79
326	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		9¾	18.00	15.80	87.79
327	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		12¾	18.00	15.80	87.79
328	Station Farm	Reno, Nevada		1	8 3–16	21.00	18.80	89.53
329	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	1	11	22.00	19.30	87.74
330	Station Farm	Reno, Nevada	Vilmorin		12¾	19.20	15 50	80.72
331	Station Farm	Reno, Nevada	Vilmorin		9½	19.20	15.50	80.72

332	Station Farm	Reno, Nevada	Vilmorin		7 9-16	19.20	15.50	80.72
333	Station Farm	Reno, Nevada	Klein Wanzlebener		11 15-16	21.60	18.80	87.03
334	Station Farm	Reno, Nevada	Klein Wanzlebener		9 7-16	21.60	18.80	87.03
335	Station Farm	Reno, Nevada	Klein Wanzlebener		4 5-16	21.60	18.80	87.03
336	Station Farm	Reno, Nevada	Desprez		13 15-16	20.00	18.20	91.01
337	Station Farm	Reno, Nevada	Desprez		5 15-16	20.00	18.20	91.01
338	Station Farm	Reno, Nevada	Desprez		8	20.00	18.20	91.01
339	Station Farm	Reno, Nevada	Simon Le Grande		15 15-16	21.20	18.50	87.28
340	Station Farm	Reno, Nevada	Simon Le Grande		10¼	21.20	18.50	87.28
341	Station Farm	Reno, Nevada	Simon Le Grande		4 15-16	21.20	18.50	87.28
342	Station Farm	Reno, Nevada	Vilmorin Amelioree	1	14⅛	19.00	17.00	89.45
343	Station Farm	Reno, Nevada	Vilmorin Amelioree		15 15-16	19.00	17.00	89.45
344	Station Farm	Reno, Nevada	Vilmorin Amelioree		5⅝	19.00	17.00	89.45
345	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		12⅛	20.40	17.80	87.25
346	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		7 5-16	20.40	17.80	87.25
347	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		4 11-16	20.40	17.80	87.25
348	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		14½	18.00	16.90	93.88
349	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		6 11-16	18.00	16.90	93.88
350	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		4 11-16	18.00	16.90	93.88
351	Station Farm	Reno, Nevada	Improved Vilmorin		11 1-16	20.20	18.20	90.10
352	Station Farm	Reno, Nevada	Improved Vilmorin		12	20.20	18.20	90.10
353	Station Farm	Reno, Nevada	Improved Vilmorin		5 1-10	20.20	18.20	90.10
354	Station Farm	Reno, Nevada	Klein Wanzlebener		11¼	21.20	20.00	94.34
355	Station Farm	Reno, Nevada	Klein Wanzlebener		7¾	21.20	20.00	94.34
356	Station Farm	Reno, Nevada	Klein Wanzlebener		5⅞	21.20	20.00	94.34
357	Station Farm	Reno, Nevada	Florimond Desprez		14 7-16	19.00	17.00	89.45
358	Station Farm	Reno, Nevada	Florimond Desprez		12 13-16	19.00	17.00	89.45
359	Station Farm	Reno, Nevada	Florimond Desprez		6⅝	19.00	17.00	89.45
360	Station Farm	Reno, Nevada	Desprez	1	4¼	19.00	17.10	89.99
361	Station Farm	Reno, Nevada	Desprez		12 7-16	19.00	17.10	89.99
362	Station Farm	Reno, Nevada	Desprez		4⅜	19.00	17.10	89.99
363	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	12	21.40	15.20	71.02
364	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	10	18.00	13.50	74.99
365	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	12½	13.40	9.50	56.57
366	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	12	15.20	10.50	69.09
367	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	2	11	12.20	5.50	45.07

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet. Lbs	Weight of Beet. Ozs.	Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
368	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	10½	14.20	9.00	56.34
369	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	11	15.80	9.50	60.10
370	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	15	13.60	8.30	61.04
371	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	1	15	17.40	13.00	74.72
372	R. Sadler	Eureka, Eureka county	Verbesseter Klein Wanzlebener	2	4	11.80	9.00	76.26
373	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	2	5	12.40	8.00	64.52
374	J. G. Young	Wabuska, Lyon county	Verbesseter Klein Wanzlebener	1	12	17.00	11.50	83.03
375	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		10 9-16	22.20	18.50	83.33
376	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		15	22.20	18.50	83.33
377	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		15 7-16	22.20	18.50	83.33
378	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		13⅝	20.40	18.20	89.22
379	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		15¾	20.40	17.10	83.83
380	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		10	20.40	21.50	94.88
381	Station Farm	Reno, Nevada	Vilmorin Amelioree	1	3½	21.20	20.10	97.02
382	Station Farm	Reno, Nevada	Vilmorin Amelioree	1	1¾	21.20	18.00	84.91
383	Station Farm	Reno, Nevada	Vilmorin Amelioree		12½	21.20	19.80	93.42
384			Desprez		15½	23.80	20.00	84.02
385			Desprez		9	23.80	23.00	96.62
386			Desprez	1	1	24.00	23.50	97.92
387					14½	21.20	20.00	94.34
388				1	3	21.20	20.80	98.12
389					7	21.20	20.50	98.96
390			Improved Vilmorin		13½	26.00	22.50	68.74
391			Improved Vilmorin		10⅜	26.00	23.30	89.61
392			Improved Vilmorin		9⅝	26.00	23.00	89.61
393	Station Farm	Reno, Nevada	Florimond Desprez		10⅝	22.60	20.00	88.49
394	Station Farm	Reno, Nevada	Florimond Desprez	1	1⅜	22.60	19.50	68.53

395	Station Farm	Reno, Nevada	Florimond Desprez	1	1 13-16	22.60	20.10	88.94
396	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	4½	22.60	20.60	91.15
397	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		11	22.60	20.60	91.15
398	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		8½	22.60	20.60	91.15
399	E. Mathews	Reno, Nevada	Verbesseter Klein Wanzlebener	1	11	20.00	17.80	89.01
400	E. Mathews	Reno, Nevada	Verbesseter Klein Wanzlebener	1	2	20.00	15.60	78.00
401	E. Mathews	Reno, Nevada	Verbesseter Klein Wanzlebener		13	20.00	18.00	90.09
402	E. Mathews	Reno, Nevada	Verbesseter Klein Wanzlebener		14½	22.50	19.20	85.32
403	E. Mathews	Reno, Nevada	Verbesseter Klein Wanzlebener		14½	22.50	15.00	66.66
404	Station Farm	Reno, Nevada	Florimond Desprez	1	8	18.20	16.20	89.00
405	Station Farm	Reno, Nevada	Florimond Desprez	1	4½	18.00	16.80	93.40
406	Station Farm	Reno, Nevada	Florimond Desprez	1	3½	18.20	15.00	82.41
407	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	1	19.50	16.10	82.56
408	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		14	20.40	17.80	87.25
409	Station Farm	Reno, Nevada	Improved Klein Wanzlebenor		11½	20.40	18.00	88.24
410	Station Farm	Reno, Nevada	Simon Le Grande	1	1½	20.40	17.60	86.27
411	Station Farm	Reno, Nevada	Simon Le Grande		14½	20.40	16.10	93.35
412	Station Farm	Reno, Nevada	Simon Le Grande		11½	20.40	16.50	80.90
413	Station Farm	Reno, Nevada	Klein Wanzlebener	1	1	19.60	16.20	82.64
414	Station Farm	Reno, Nevada	Klein Wanzlebener		10	19.60	17.20	87.74
415	Station Farm	Reno, Nevada	Klein Wanzlebener		5½	19.60	19.50	99.47
416	Station Farm	Reno, Nevada	Desprez		15	20.00	17.40	86.99
417	Station Farm	Reno, Nevada	Desprez		11½	20.00	17.00	84.99
418	Station Farm	Reno, Nevada	Desprez		9	20.00	18.40	92.00
419	Station Farm	Reno, Nevada	Vilmorin Ameliorее		13	20.20	18.50	91.57
420	Station Farm	Reno, Nevada	Vilmorin Amelioree		13	20.20	17.00	84.13
421	Station Farm	Reno, Nevada	Vilmorin Amelioree		11½	20.20	17.50	86.61
422	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		12	21.80	17.10	78.43
428	Station Farm	Reno, Nevada	Vesbesseter Klein Wanzlebener		9	21.80	15.50	71.09
424	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		8	21.80	16.10	73.84
425	Station Farm	Reno, Nevada	Improved Vilmorin		8½	20.90	18.50	88.53
426	Station Farm	Reno, Nevada	Improved Vilmorin		9	20.90	17.50	83.73
427	Station Farm	Reno, Nevada	Improved Vilmorin		7½	20.90	17.50	83.73
428	Station Farm	Reno, Nevada	Klein Wanzlebener	1	8 3-16	21.10	18.80	89.10
429	Station Farm	Reno, Nevada	Klein Wanzlebener	1	11	22.00	19.30	87.74
430	Station Farm	Reno, Nevada	Klein Wanzlebener	1	15-16	21.20	15.00	70.76

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet.		Per Cent. of total Solids.	Per Cent. of Sucrose.	Purity.
				Lbs	Ozs.			
431	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	5 9-16	16.80	15.10	89.88
432	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	5-16	18.40	17.50	95.10
433	Station Farm	Reno, Nevada	Improved Klein Wanzlebener		13 3.16	17.60	17.50	99.42
434	Station Farm	Reno, Nevada	Vilmorin	1	2 5-16	18.20	16.30	89.55
435	Station Farm	Reno, Nevada	Vilmorin	1	7 3-16	18.60	17.80	95.70
436	Station Farm	Reno, Nevada	Vilmorin		11 15-16	18.20	17.60	98.94
437	Station Farm	Reno, Nevada	Simon Le Grande		14 7-16	23.40	20.20	86.33
438	Station Farm	Reno, Nevada	Simon Le Grande		14 9-16	24.60	21.60	87.82
439	Station Farm	Reno, Nevada	Simon Le Grande		11¼	24.20	21.00	86.77
440	Station Farm	Reno, Nevada	Florimond Desprez		15 15-16	19.20	17.80	94.86
441	Station Farm	Reno, Nevada	Florimond Desprez		13 7-16	18.30	17.20	93.97
442	Station Farm	Reno, Nevada	Florimond Desprez		11 3-16	18.30	17.20	93.97
443	Station Farm	Reno, Nevada	Desprez		13⅜	20.00	18.00	95.43
444	Station Farm	Reno, Nevada	Desprez		10⅛	18.80	14.40	76.60
445	Station Farm	Reno, Nevada	Desprez		11¼	18.80	14.40	76.60
446	Station Farm	Reno, Nevada	Vilmorin Amelioree	1	5 14-16	17.00	16.80	98.83
447	Station Farm	Reno, Nevada	Vilmorin Amelioree		12 15-16	19.80	17.50	88.36
448	Station Farm	Reno, Nevada	Vilmorin Amelioree		8 13-16	18.60	17.60	94.62
449	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		13 7-16	18.60	17.60	94.62
450	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		9¾	18.20	14.30	78.56
451	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener		8⅞	18.20	14.30	78.56
452	Station Farm	Reno, Nevada	Klein Wanzlebener	4	8½	17.20	15.10	87.80
453	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	5	2	15.00	11.00	73.31
454	Station Farm	Reno, Nevada	Desprez	2	10	15.60	13.40	85.90
455	B. F. Leete	Reno, Nevada	Desprez	3	8½	15.20	11.80	77.74
456	B. F. Leete	Reno, Nevada	Desprez	2	13½	14.60	11.80	80.81
457	B. F. Leete	Reno, Nevada	Desprez	2	6	16.20	13.40	82.71

458	B. F. Leete	Reno, Nevada	Desprez	1	6½	14.80	11.80	76.34
459	B. F. Leete	Reno, Nevada	Desprez	1	3	18.20	14.10	77.46
460	B. F. Leete	Reno, Nevada	Desprez	1	4 15-16	16.40	13.70	83.54
461	B. F. Leete	Reno, Nevada	Desprez	....	13 9-16	18.20	15.50	85.25
462	B. F. Leete	Reno, Nevada	Desprez	....	12 1-16	18.20	14.40	79.12
463	B. F. Leete	Reno, Nevada	Desprez	....	11¼	18.20	14.50	79.67
464	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	1	8½	19.40	16.20	83.50
465	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	....	7½	19.60	16.70	85.20
466	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	....	5¾	19.60	16.70	85.20
467	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	2	3	17.60	14.70	83.52
468	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	1	3½	18.20	16.50	92.76
469	Station Farm	Reno, Nevada	Improved Klein Wanzlebener	....	5½	19.40	17.10	88.14
470	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	....	8	19.70	17.50	88.81
471	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	....	15½	20.10	18.20	90.55
472	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	2	4	18.60	16.00	86.02
473	Station Farm	Reno, Nevada	Verbesseter Klein Wanzlebener	3	8½	15.20	12.50	82.24
474	Station Farm	Reno, Nevada	Gebruder	....	7½	20.00	18.10	86.43
475	Station Farm	Reno, Nevada	Gebruder	1	13	18.20	15.30	84.06
476	Station Farm	Reno, Nevada	Gebruder	1	9	19.00	15.70	82.62
477	Henry Fish	Eureka, Eureka county	Desprez	1	10¼	14.00	11.90	85.00
478	Henry Fish	Eureka, Eureka county	Desprez	1	13 1-16	15.40	13.20	85.68
479	Henry Fish	Eureka, Eureka county	Desprez	1	5 3-16	16.40	14.30	87.20
480	Henry Fish	Eureka, Eureka county	Desprez	1	10⅞	18.40	15.00	81.52
481	Henry Fish	Eureka, Eureka county	Desprez	1	9 11-16	16.40	13.60	82.92
482	Henry Fish	Eureka, Eureka county	Desprez	1	8⅜	16.10	14.30	89.37
483	Henry Fish	Eureka, Eureka county	Desprez	1	13 5-16	14.00	12.10	86.43
484	Henry Fish	Eureka, Eureka county	Desprez	1	15⅜	15.60	13.50	86.53
485	Henry Fish	Eureka, Eureka county	Desprez	1	13 5 16	14.20	12.05	84.85
486	Henry Fish	Eureka, Eureka county	Desprez	2	14 15-16	13.60	11.50	84.56
487	Henry Fish	Eureka, Eureka county	Desprez	1	14¾	13.50	11.35	84.08
488	Henry Fish	Eureka, Eureka county	Desprez	1	⅞	15.10	13.60	90.05
489	Henry Fish	Eureka, Eureka county	Desprez	1	5 7-16	14.20	12.10	85.21
490	Henry Fish	Eureka, Eureka county	Desprez	1	4 7-16	15.15	13.00	85.80
491	C. R. Flannagan	Wells, Elko county	Verbesseter Klein Wanzlebener	1	7 7-16	19.00	16.60	87.35
492	C. R. Flannagan	Wells, Elko county	Verbesseter Klein Wanzlebener	1	2 5-16	20.00	18.30	91.51
493	C. R. Flannagan	Wells, Elko county	Verbesseter Klein Wanzlebener	1	1 3-16	20.60	18.50	89.80

TABLE SHOWING GENERAL SUMMARY OF ALL ANALYSES FOR THE YEARS 1891–92.—*Continued.*

Station No.	GROWER.	Postoffice Address.	Variety of Beets.	Weight of Beet		Per Cent. of total solids.	Per Cent. of Sucrose.	Purity.
				Lb	Ozs.			
494	J. Symon........	....	....	1	7⅜	21.00	18.90	90.01
495	J. Symon........	....	....	1	13-16	20.30	17.95	88.42
496	J. Symon........	....	....	1	14 3-16	19.00	16.55	87.10
497	J. Symon........	....	....	1	1 3-16	18.50	16.40	88.63
498	J. Symon........	....	....	1	15-16	21.50	19.00	88.38
499	J. Symon........	....	....	....	10 9-16	20.20	18.50	91.57
500	Chris Rabe......	Sheridan, Douglas county........	Vilmorin Amelioree............	1	8⅝	15.40	13.10	85.07
501	Chris Rabe......	Sheridan, Douglas county........	Vilmorin Amelioree............	1	3 9-16	16.20	14.20	87.65
502	Chris Rabe......	Sheridan, Douglas county........	Vilmorin Amelioree............	1	2¾	16.40	14.60	89.04
503	Chris Rabe......	Sheridan, Douglas county........	Vilmorin Amelioree............	1	15¼	16.10	14.00	86.95
504	Chris Rabe......	Sheridan, Douglas county........	Vilmorin Amelioree............	....	7 7-16	15.20	13.10	86.20
505	Chris Rabe......	Sheridan, Douglas county........	Vilmorin Amelioree............	....	3⅝	15.50	13.20	85.27
506	John Harrison...	Lovelocks, Humboldt county.....	Common Mangle Wortzel......	2	10	17.00	3.50	48.56
507	....	....	....	1	10	17.50	15.20	88.87
508	....	....	....	....	10¼	17.20	14.50	84.32
509	....	....	....	....	13	17.60	14.80	84.10
510	J. Yount	Pakramp Valley........	....	....	13⅞	18.20	15.60	85.70
511	J. Yount........	Pakramp Valley........	....	....	10⅜	16.40	13.80	84.15
512	J. Yount........	Pakramp Valley........	....	1	3-16	19.50	17.60	90.26
513	....	....	....	9	1 15-16	17.80	14.15	81.80
514	....	....	....	....	9¼	18.50	16.30	88.10
515	....	....	....	....	7 7-16	19.30	17.00	88.06
516	C. L. Deady......	Belmont, Nye county........	Verbesseter Klein Wanzlebener	....	7½	15.30	13.40	86.28
517	C. L. Deady......	Belmont, Nye county............	Improved Vilmorin............	...	10¾	16.20	14.00	86.42
518	C. L. Deady......	Belmont, Nye county............	Improved Vilmorin............	2	3¼	16.80	14.40	85.18
519	C. L. Deady......	Belmont, Nye county............	Florimond Desprez............	....	6¾	13.40	11.00	82.08
520	C. L. Deady......	Belmont, Nye county............	Florimond Desprez............	....	13½	17.10	14.90	87.13
521	C. L. Deady......	Belmont, Nye county............	Verbesseter Klein Wanzlebener	....	5⅛	16.50	14.30	86.66

EARLY FLORA OF THE TRUCKEE VALLEY.

NEVADA STATE UNIVERSITY.

◆

Agricultural Experiment Station.

BULLETIN NO. 24.

Reno, Nevada, November, 1894.

Early Flora of the Truckee Valley.

Embracing the Commoner Flowering Plants Occurring Within the Truckee Valley, Washoe Co., Nevada, by Midsummer.

FRED H. HILLMAN, M. S.

INTRODUCTION.

The following descriptive list is issued as a preliminary step toward a future and more complete Flora of Nevada. It is believed that this partial list will aid materially in the consummation of the work necessary to this end.

The text has been prepared with especial reference to practical use in plant determination by students in the common schools and others.

The descriptions have been drawn up by the author from ample fresh material constantly influenced by the text of our leading manuals and reports.

The characterizations of the families and genera have been confined, in the main, to such plants as are here described.

While many omissions will be observed, it is hoped that this effort may encourage an interest in Nevada's wild flora, for the study of which no popular guide has thus far appeared. The short glossary includes only such words as occur in the text.

April, 1895. F. H. H.

KEY TO THE ORDERS.

The following plants all having true flowers producing seeds belong to the series, Phænogamia or Flowering Plants.

The Phænogamia embrace:—

Class I. Plants having the ovules in a closed ovary... Angiospermæ.

Class II. (*Not included in our list*) Plants having the ovules naked (e. g. the cone bearers).............. Gymnospermæ.

ANGIOSPERMÆ.

Flowers with a pistil consisting essentially of an ovary and stigma. The ovary closed containing the ovules, which become seeds.

Sub-class I. Dicotyledons. Embryo having two cotyledons. Leaves net-veined. Parts of the flower usually in 4's and 5's.

Division I. Polypetalæ. Calyx and corolla both present; the latter of separate petals.

A Stamens more than 10.

I. Stamens hypogynous, free.

Pistils simple, few to many....................... Ranunculaceæ. 1

Pistil compound, as evident in the number of cells, placentæ, or stigmas.

  Petals 4 or 6, falling readily; calyx falling with the opening of the flowers.................. Papaveraceæ. 3

  Petals 8–16; flowers showy; style 3–8-parted .... Portulacaceæ. 22

  Petals 5; calyx cleft; filaments forming a tube about the style..... .... Malvaceæ. 24

  Petals 5; sepals distinct; stamens in 3 clusters; leaves punctate .... Hypericaceæ. 19

II. Stamens on the calyx.

Leafy, succulent herbs, ovary 1-celled............. Portulacaceæ. 22

Not fleshy or succulent; leaves alternate.

Leaves stipulate .... ROSACEÆ. 36

Leaves not stipulate, rough .... LOASACEÆ. 44

B Stamens 10, or less.

I. Ovary or ovaries superior.

* Pistils many.

Stamens 10, on the calyx .... ROSACEÆ. 36

* * Pistil solitary.

+ Pistil simple; as evident in the single cell, placenta or stigma.

Flowers irregular; leaves pinnate or palmate .... LEGUMINOSEÆ. 28

Flowers regular; leaves mostly stipulate; fruit a drupe .... ROSACEÆ. 36

+ + Pistil compound, as evident in the number of cells, placentæ, styles or stigmas.

Ovary 1 celled with 2 parietal placentæ.

Corolla irregular, the lower petal spurred .... VIOLACEÆ. 18

Petals and sepals 4; stamens 6 .... CAPPARIDACEÆ. 16

Ovary and pod 2-celled, petals 4, stamens tetradynamous .... CRUCIFERÆ. 4

Ovary and capsule 1-celled, few or many seeded with a central placenta

Sepals 2; leaves opposite or alternate .... PORTULACACEÆ. 22

Sepals or calyx lobes 5 or 4; leaves all opposite .. CARYOPHYLLACEÆ. 20

Ovary 5-celled and lobed; leaves pinnate or palmate .. GERANIACEÆ. 27

II. Ovary and fruit inferior, or mainly so.

Shrub; fruit a 1-celled, many-seeded berry .... SAXIFRAGACEÆ. 39

Herbs; ovary 2 to 4-celled .... ONAGRACEÆ. 40

Herbs; flowers in umbels; styles 2; fruit dry .... UMBELLIFERÆ. 45

DIVISION II. GAMOPETALÆ. Flowers with the calyx not always evident. Petals united to form one piece.

A Ovary inferior.

Stamens as many as the corolla lobes (mostly 5), syngenesious.

Flowers in an involucrate head .... COMPOSITÆ. 47

Flowers separate, scattered .... LOBELIACEÆ. 60

Stamens only 3; corolla spurred; leaves opposite .... VALERIANACEÆ. 46

B Ovary superior.

Petals but slightly united at base; pistil simple; leaves compound; stamens 10 .... LEGUMINOSEÆ. 28

Stamens of same number as the lobes of the corolla and alternate with them or fewer.

* Corolla regular.

Pollen in solid waxy masses; fruit a pair of follicles... ASCLEPIADACEÆ. 61

Ovary 4-lobed, forming 4 seed-like nutlets; style various........ .... BORRAGINACEÆ. 68

Ovary single and entire.

  Style 3-cleft at apex; capsule 3-celled; corolla convolute........ .... POLEMONIACEÆ. 61

  Styles 2 (or 1 and 2-cleft); capsule 1 to 2-celled ................................HYDROPHYLLACEÆ. 66

* * Corolla irregular.

Ovary and capsule 2-celled; stamens (with anthers) 4 or 2; style 1 ............................SCROPHULARIACEÆ. 72

DIVISION III. APETALÆ. Corolla (and sometimes the calyx) wanting.

Ovary enclosed by the calyx, apparently inferior; perianth corolla-like.............................. NYCTAGINACEÆ. 76

Ovary and fruit superior

  Ovary 1-celled, 1-ovuled, 3-angled; styles 3; stigmas capitate............................. POLYGONACEÆ. 76

  Ovary 2-celled, nearly orbicular; style 1, short. Lepidium in CRUCIFERÆ. 5

SUB-CLASS II. MONOCOTYLEDONS. Embryo with a single cotyledon. Leaves mostly parallel veined. Flowers usually 3-merous.

Ovary inferior; stamens 3; leaves equitant........... IRIDACEÆ. 78

Ovary superior; stamens 6; from a bulb, corm, or rhizoma.................................... LILIACEÆ. 79

RANUNCULACEÆ.

CROWFOOT FAMILY.

Herbs with numerous hypogynous stamens. Pistils few or many. Floral organs distinct and free. Sepals commonly colored and petal-like. Seeds one to several. Leaves simple or compound. Stipules none. Ours all perennials.

Flowers regular; pistils numerous . . . . RANUNCULUS.
Flowers irregular; calyx spurred; pistils 3 . . . . DELPHINIUM.
Flowers bud-like, purple tinged; leaves proportionately large . . . . PÆONIA.

RANUNCULUS. CROWFOOT, BUTTERCUP. Flowers yellow or white. Sepals and petals 5 each in ours. Akenes numerous, flattened, in globular or oblong heads. Leaves various.

R. Cymbalaria, Pursh. Rooting from slender runners: 3–6 in. high: glabrous or slightly pubescent: leaves all radical, clustered, long petioled, rounded or ovate, cordate, crenate, ¾ in. to 1 in. or more broad: flower stems simple, branching with age: flowers yellow, shining, petals often whitish, 2-3 lines long: sepals greenish tinged: akenes numerous in an oblong head ½ in. or less long.—Very common in moist places. May-Aug.

R. occidentalis, Nutt. Very slender, 12–18 in. high, with several erect or ascending branches from the base: softly long pubescent below, slightly so or glabrous above: radical leaves slender petioled, 3–6 in. long, 3-5 parted, the segments more or less cleft: cauline leaves short petioled or sessile, segments entire: flowers on slender peduncles, bright yellow, the shining petals 3-4 lines long: akenes about 12, nearly orbicular, 1-1½ lines broad, in a globose head.—Found in moist shady places. Common along the Truckee River. May-Sept.

R. aquatilis, L., var. **trichophyllus,** Chaix. Submerged and floating in slow running water: glabrous: stems slender, becoming a foot or two long: leaves an in. or less long, dark green, divided into numerous capillary segments: peduncles an in. or two long: flowers white with yellow center, 5-7 lines broad: petals broadly obovate, much larger than the reflexed sepals: fruiting heads 2-3 lines broad.—Very common in the irrigating ditches in the lower parts of the valley. May-Sept.

DELPHINIUM. Larkspur. Calyx colored, spurred. Petals 4, 2 extending into the spur. Fruit of 3 erect follicles.

D. decorum, Fisch & Mey. Erect from a coarse perennial root: stems one or more, rather stout, 1-3 ft. high: leaves chiefly radical, petiolate, the blade circular in outline, 1–2 in. in diameter, about 5-divided palmately, the segments variously lobed to parted, the upper leaves with fewer, narrower and more entire segments: flowers large, blue, in a showy raceme, calyx expanding ¾ in. or more, spur ½ in. long.—Common among sagebrush. May, June.

PÆONIA. Flowers bud-like. Sepals and petals imbricated, the former herbaceous. Carpels several seeded.

P. Brownii, Dougl. A leafy plant from a thick, deep, root stock, 10–20 in. high, smooth, somewhat glaucous: leaves ample, 4–5 ins. long, petiolate, once or twice pinnately compound, the segments lobed or parted: flowers terminating the stem, ¾–1 in. broad, sepals 5, purplish: petals 5.10, rounded, deep purple externally: carpels 3-5 on a flat receptacle: seeds ¼ in. or more long, dark brown.—Sierra Nevada foothills and about Washoe Lake. May.

PAPAVERACEÆ.

POPPY FAMILY.

Herbs, the perfect flowers with hypogynous sepals, petals and numerous stamens. Petals 4 or 6 in ours, falling early. Ovary 1-celled, placentæ parietal. Capsule 1-celled. Seeds numerous.

* Flowers conspicuous, petals 6, white..............	ARGEMONE.
* * Flowers yellow, petals 4.......................	ESCHSCHOLTZIA.

ARGEMONE. Sepals 2 or 3. Capsule erect, opening at the top. Seeds many.

A. hispida, Gray. PRIKCLY POPPY. Biennial, erect or spreading, 2 ft. or more high, glaucescent, thickly set with spreading prickles throughout: leaves 3–6 in. long, 1–2 in. broad, coarsely pinnately lobed or cleft, the segments toothed, winged petiolate below, sessile above: flowers short, pedunculate, 3–4 in. broad, the staminate center yellow: capsule nearly 2 in. long.—This is the conspicuous white poppy common along dry roadsides and hillsides. June-Sept.

ESCHSCHOLTZIA. Smooth, glaucous, erect or spreading. Leaves petioled and finely dissected into mostly linear segments. Flowers yellow. Petals 4, broad and rounded. Calyx forming a cap falling with the opening of the flower. Capsule linear, tapering at each end, striate, opening lengthwise. Seeds in two rows.

E. Californica, Cham. CALIFORNIA POPPY. 1–2 ft. high in this locality, apparently perennial: leaves 2–5 in. long: flowers 1½–2 in. broad, light to dark yellow, the petals orange at base: capsule 2–2½in. long, straight or curved, erect.—The California poppy is found in the Sierra Nevada foothills above Laughton's Springs. June-Sept.

E. minutiflora, Watson. An annual, very similar to the last, a ft. or less high, the herbage apparently darker, stems very slender: leaves smaller: flowers about ¼ in. broad: the capsule 1–1½ in. long.—Found in the Truckee Pass, Virginia Mts. June.

CRUCIFERÆ.

MUSTARD FAMILY.

Herbs with more or less pungent juice and alternate, exstipulate leaves. Flowers perfect, hypogynous. Sepals and petals 4 each. Stamens tetradynamous (or fewer in Lepidium). Ovary 2-celled with 2 parietal placentæ (except in the last). Style simple or none. Stigma simple or 2-lobed. Fruit a pod, from orbicular to linear. Seeds few or many, the cotyledons incumbent, accumbent or oblique.

* Pods dehiscent, 2-valved.

Pods proportionately large, orbicular; seeds broadly winged.......................................PLATYSPERMUM.

Pods elongated (over ¾ in. long, except in Thelypodium); flowers ¼–½ in. or more long (except in Barbarea).

  Pods linear, thin, straight or curved, abruptly pointed; flowers pink or purple........................ ARABIS.

  Pods similar to the preceding; leaves broad, clasping, the lower spatulate, dentate; sepals purplish...... STREPTANTHUS.

  Pods tapering, thin, spreading; flowers bright purple.. CHEIRANTHUS.

  Pods stipitate.

    Pods long, slender or shorter and pointed; very short stipitate; flowers white or rose-colored. THELYPODIUM.

    Pods slender, long stipitate; flowers large, yellow. STANLEYA.

  Pods prominently beaked, nearly terete; flowers yellow...................................... BRASSICA.

  Pods slender (at least an in. long), slightly angled; flowers yellow, often less than ¼ in. long......... BARBAREA.

Pods short (less than ¾ in. long, except in sisymbrium); flowers less than ¼ in long

- Pods various; leaves finely dissected; flowers yellow. . SISYMBRIUM.
- Pods various; leaves pinnatifid to lyrate; flowers yellow or white; in water or on moist ground. . . . . NASTURTIUM.
- Pods pear-shaped; leaves broad, sagittate; flowers cream yellow. . . . . CAMELINA.
- Pods flat, triangular, notched, or short oblong; flowers white. . . . . CAPSELLA.
- Pods flat; nearly orbicular, notched; petals white or absent; stamens 2, 4 or 6. . . . . LEPIDIUM.

* * Pods indehiscent, 1-celled.

Pods thin, nearly orbicular, plano-convex, thin margined; flowers minute. . . . . THYSANOCARPUS.

PLATYSPERMUM. Pod orbicular, flat. Valves nerveless. Partition hyaline. Seeds thin, winged.

P. scapigerum, Hook. A delicate glabrous annual, the half dozen or less radical leaves ½–¾ in. long, entire or pinnately toothed or "runcinately pinnatifid:" spatulate to petiolate, orbicular: flowers "small, white" terminating singly the 1–4 or 5 slender scapes which are 1½–2½ in. high: pods 3–4 lines in diameter, the minute style persistent: seeds 8–12, ½ line or more in diameter, the wing as wide as the seed.—An inconspicuous plant growing among sage-brush upon the dry foothills in April and May; soon disappearing.

ARABIS. Pod flattened, linear. Valves 1-nerved. Pedicels ½ in. or less long. Petals 4–5 lines long, about twice the length of the sepals, with narrow claw and flat blade. Stamens included. Anthers short. Style none in ours. Cotyledons acumbent. Ours perennials.

A. arcuata, Gray. Erect or branching from a simple or branched base, 2–3 ft. high: pubescence finely hirsutely-villous, with branched hairs, often sparingly present upon the inflorescence: leaves entire or rarely toothed: the lower oblanceolate, 2–3 in. long, distinctly clustered: the cauline lanceolate 1–2 in. long, distinctly auriculate-sagittate, clasping or the bases reflexed: flowers purple, erect or ascending, pods slender, ascending, or rarely reflexed, curved outwardly, 2–3½ in. or more long, a line wide: seeds thin, usually narrowly margined.—Common among sage-brush and rocks upon the hills and along valley roadsides. April-July

A. Holbœllii, Hornem. Erect, 1–2 ft. high, virgate or branching, from a usually simple base: pubescence minutely stellate, often canescent, usually embracing the inflorescence: lower leaves 1–2 in. long, narrowly spatulate to oblanceolate, dentate to entire, not distinctly clustered, the cauline strict or ascending, lanceolate, 1–1½ in. long, entire or denticulate, sagittate or obscurely so, the lower margins and lobes often reflexed: flowers usually rose-pink, often purple, sometimes nearly white, usually soon reflexed: pods reflexed or pendulous; 1½–2¼ inches long, about a line wide, usually straight. —Associated with the last.

A. suffrutescens, Watson. Slender, erect, from a simple often elongated woody base, pubescence minutely stellate throughout: lower leaves slender, oblanceolate, 1–3 in. long, entire, the cauline linear-lanceolate, 2–3 in. long, narrow and entire at base: flowers purple, soon reflexed: young pistils canescently pubescent: pods pendulous, 1½–2 in. long, 1½–2 lines broad: seeds distinct in two rows, thin, a line broad, distinctly margined.—Not common; found in the Sierra Nevada and Virginia foothills in June.

STREPTANTHUS. Pod linear, valves 1-nerved. Petals with narrow twisted blade. Sepals colored. Seeds accumbent.

S. cordatus, Nutt. Perennial, glabrous and usually glaucous: stems mostly simple, ascending or erect from a simple or branched base, 1–3 ft. high: lower leaves ovate, or obovate-spatulate, 2–4 in. long, serrate-dentate especially toward the apex, the teeth usually setosely tipped: cauline leaves sessile, 1–2 in. long, cordate to oblong or ovate-lanceolate, obtuse or acute, often cuspidate, the bases broadly auriculate and clasping: flowers racemed, ascending; sepals 4–5 lines long, broad, purplish, the lateral pair gibbous at base; petals a half longer, greenish-yellow below, the narrow limb deep purple; anthers exserted, sagittate; stigma simple, sessile: pods erect or ascending, 2–3 in. or more long, about 2 lines wide, straight or curved; the stout pedicels ¼ in. long, seeds in one row, thin, 1–1¼ lines broad, narrow margined.—Along the higher banks of the Truckee River. June–Sept.

CHEIRANTHUS. Pod as in Streptanthus, but more tapering. Petals with slender claw and flat limb. Sepals not colored. Seeds accumbent.

C. Menziesii, Benth. and Hook. A tufted perennial from a stout long-persistent, simple or branched rootstock: pubescence minute, stellate, dense: leaves mostly radical, 3–6 in. long, oblanceolate to oblong-lanceolate, the petioles slender, winged: stems scape-like, 6–18 in. high, bearing few bract-like, ovate to lanceolate leaves an in. or less long with a simple or auriculate clasping base: flowers bright purple, racemed, densely clustered; sepals 2 lines long, light green, the lateral pair gibbous; petals about 5 lines long: pods spreading, thin, 1-3 in. long, 2 lines or less broad at base, attenuate to the short slender style: pedicels ½–1 in. long: seeds in one row.—Occurs commonly in exposed rocky places on the hills. Spring and early Summer.

THELYPODIUM. Mostly biennials. Petals mostly narrow, about twice the length of the sepals. Stigma entire. Pods linear, terete or nearly so, torulose, terminated by a short slender style. Valves 1-nerved. Pedicels ¼ in. or less long. Stipe a line or less long in ours. Seeds in one row, light colored, the hilum darker. Cotyledons incumbent or oblique.

T. integrifolium, Endl. Stout, erect, 3–6 ft. high, branching chiefly at the summit: leaves entire, the radical 6–12 in. long, petiolate, long, elliptical to lanceolate: the cauline short, petiolate to sessile with a narrow base linear-lanceolate above: flowers rose-colored to purple, in close clusters; petals 4 lines long with a flat elliptical limb; sepals narrowed and greenish at the apex; stamens exserted: fruiting racemes dense, 2 in. or less long: pods spreading to ascending, an inch more or less long.—Not generally distributed, but found in a protected locality in the Truckee river canyon, Va. Mts., under willows. July-Sept.

T. laciniatum, Endl. Coarse, erect, branching from below: leaves petiolate, the lower 4–8 in. long: petiolate slender; blade broad, coarsely and irregularly sinuate toothed to cleft: flowers white in dense elongated racemes; petals with a linear limb, 6–7 lines long; sepals equally saccate and broadest at base; anthers exserted: fruiting racemes 6 in.–1 ft. or more long, dense: pods spreading horizontally, often upward curved, 1½–3 in. long.—Commonest on sandy banks of the Truckee river and on high rocky places where seeds have been carried by birds. June, July.

T. brachycarpum, Torr. Apparently an annual, slenderer than the preceding species: erect and virgate, 2–4 ft. high, branching chiefly above, or those in shaded places with weaker more branching stems, glaucous:

radical leaves 2–4 in. long, oblanceolate to spatulate with winged petiole, toothed to pinnatifid: the cauline oblanceolate to lanceolate, entire or dentate, sagittate, clasping: flowers white in crowded slender racemes; petals narrowly linear, 4 lines long; sepals greenish tipped; filaments exserted: pods ascending, 6–9 lines long.—Not generally distributed, but growing abundantly in certain saline localities. July-Sept.

STANLEYA. Pod very slender. Sepals narrow, yellow. Petals with long claws. Stipe long. Stamens elongated.

S. pinnatifida, Nutt. Perennial 3–6 ft. high, more or less glaucous, somewhat puberulent: leaves all petiolate, the lowest lyrate-pinnatifid, 2–3 in. long, the intermediate lanceolate pinnatifid to pinnatisect, 4–6 in. long, the uppermost entire: flowers in a slender raceme 1 ft. or more long; large calyx and corolla equal, 7–8 lines long; sepals spreading or reflexed; petals with flat, elliptical, yellow limb, the slender pubescent claw broadest at the base; stamens long-exserted: pods erect or ascending "2 in. long," a line wide; tapering below to the slender stipe ¾–1 in. long and pubescent at base, and above to the sessile stigma.—Found in a single locality on the lower foothills of the Sierra Nevada Mts. June, July.

BRASSICA. Mustard. Biennial or annual: branches spreading, glabrous or sparingly beset with short stiff hairs chiefly below. Lower leaves coarse, mostly lyrate-pinnate, the terminal lobe large, coarsely and irregularly sinnate-toothed or -lobed, 4–6 in. long. Flowers yellow. Petals 3–4 lines long with spreading rounded limb, nearly twice longer than the yellowish sepals. Anthers sagittate, included or slightly exserted. Style present. Stigma rounded, entire.

B. campestris, L. 1–3 ft. high, usually glabrous and glaucous: cauline leaves lanceolate, broadly lobed and clasping at base: petals without distinct claw: pods nearly terete, slender, ascending on spreading pedicels, 1–1½ in. long; the slender style ½ in. or more long.

B. nigra, Boiss. 2–5 ft. high, more spreading, foliage darker: all the leaves petiolate: the cauline lanceolate to elliptical, irregularly toothed: petals distinctly and narrowly clawed: pods distinctly 4-angled, erect or closely appressed, ½–¾in. long: the style very slender, 1–1½ lines long.—Brassica campestris is by far the commoner and is found generally distributed over both neglected and cultivated lands. B. nigra seems to be confined to the vicinity of the railroads fact which with its scarcity indicates comparatively recent introduction. Both species appear to be subject to great structural variation, and while the descriptions apply to the specimens most frequently met, representatives of each species are found bearing the leaf or pod characters of the other, also other variations in the form of the pods. Flowering during Summer and Autumn.

BARBAREA. Pods linear, somewhat angled. Seeds in one row. Stems often angled.

B. vulgaris, R. Br. WINTER CRESS. Perennial, 1–3 ft. high, glabrous, branching from the base or simple: leaves lyrate-pinnate, the lower 2–3 in. long, the terminal lobe rounded, entire to sinuately toothed or lobed: lateral segments from none to 5 pairs, frequently the former, the terminal lobe in the cauline more oblong: flowers yellow, clustered, 2–3 lines long: the petals without distinct claw, about twice the length of the yellowish sepals; stamens included; anthers short oblong: stigma simple: pods nearly straight, ascending on pedicels ¼ in.

long, 1–1½ in. long and a line wide, abruptly tipped by the minute style.—A cosmopolitan plant found in damp places during Summer.

SISYMBRIUM. HEDGE MUSTARD. Annuals. Pubescence minutely stellate, becoming glandular in the inflorescence except in the first species. Leaves 2–4 in. long, mostly finely bipinnately dissected into linear or oblong segments. Flowers in small terminal, umbellate clusters, yellow, a line or more long. Pods short clavate to linear, ascending on spreading pedicels. Seeds oblong, minute, incumbent.—Common from May to Aug.

S. incisum, Engelm. 1–3 or 4 ft. high, virgate, or branching above: cineraceous, characteristically dark green, stem often purplish in age: ultimate leaf segments densely numerous, linear, often in-curved claw-like: flowers slender, very light yellow; petals spatulate, shorter than the sepals: fruiting racemes 6 in.–1 ft. long: pods very slender ¾ in. more or less long, straight or in-curved, exceeding the pedicels: seeds in a single row. —Found in quantity on restricted areas along roadsides.

S. canescens, Nutt. At first virgate, branching profusely with age: 1–2 ft. high: somewhat canescent when young: leaves sparingly dissected, the ultimate segments linear to oblong, the lower often and the upper usually pinnate with linear segments: flowers bright yellow, the petals equalling or exceeding the broader sepals: pods broadly linear, ½ in. long with pointed extremities, often shorter than the pedicels: seeds in two rows.—Generally distributed, often in noxious quantities in meadows.

Var. **brachycarpum,** Watson. Differs from the species in being smaller, more delicate and diffuse: flowers smaller and in smaller clusters, rarely if ever canescent: pods clavate or elliptical, 2–3 lines long on shorter pedicels.—Usually in sandy places.

NASTURTIUM. Glabrous plants growing in or near water. Flowers small, yellow or white. Pods mostly terete, short and thick or broadly linear. Cotyledons accumbent Stems and herbage often purplish.

* Flowers small, pale yellow.

N. curvisiliqua, Nutt. Annual or biennial, 1–3 ft. high; virgate or branching from the base, smooth: leaves erect or ascending, slender, oblanceolate, 4–6 in. long, rather uniformly pinnately parted except near the apex, the segments serrate-dentate, acute and callous tipped: flowers clustered at the extremities of the branches, a line or more long; petals rounded, equalling the sepals: pods 3–4 lines long, turgid, usually broadest at base, ascending, the spreading pedicels 2 lines long: seeds numerous, minutely granular.

Var. **lyratum,** Watson. Low, the slender branches diffuse from the base: leaves lyrate, the segments more coarsely toothed, and often narrowed at base, not at all strict: flowers a line or less long in clusters ½ in. or less broad: pods shorter and more turgid, often ovoid.—The species is common in moist places, but not found in abundance. It flowers during Summer and early Autumn. The variety is here described from a single specimen collected in Northern Nevada by Prof. W. McN. Miller. It is not known to occur within our range.

N. sinuatum, Nutt. Smooth or slightly roughened, apparently an annual, having a slender tap-root; from 1–6 ins. high; the branches slender, diffuse, decumbent to ascending: leaves 1–3 in. long, pinnately divided into few pairs of entire or dentate segments which are usually narrowed at base: flowers in short racemes which little exceed the leaves, a line or less long: pods slender, 4–5 lines long, often tapering and curved; pedicels about a line long: seeds similar to the preceding.—Commonest on moist open ground, and low banks of streams. June-Oct.

* * Flowers larger, white; perennial.

N. officinale, R. Br. WATER CRESS. Aquatic: the fibrous roots copious: stems diffuse, weak, rooting at the lower nodes, 6 in. to 2 ft. long: leaves pinnate, lateral leaflets usually in pairs, oval or oblong, few or none, the terminal leaflet largest, all more or less sinuately lobed: the white flowers in terminal clusters, often purplish tinged, 2 lines long; the petals with broad limb, nearly twice longer than the sepals: pods 6–7 lines long, acute at the extremities, straight or curved on equal spreading pedicels: seeds distinctly in two rows, larger than the preceding, reticulate.—Common in the smaller ditches in the lower portions of the valley where its frequent rank growth becomes an obstruction to irrigation. Summer and Autumn.

CAPSELLA. Annuals with small white flowers. Pods oblong or triangular, flattened contrary to the narrow partition. Seeds incumbent.

C. divaricata, Walp. Smooth, 3–"12" in. high, glabrous or sparingly and very minutely stellate-pubescent: branches very slender, diffuse: leaves entire, or "pinnate or pinnatifid with few lobes," the lowest spatulate, ½ in. long, becoming oblanceolate, the cauline lanceolate with narrowed base, an in. or less long, linear above: flowers few in a small terminal cluster: pedicels slender, ascending, 3 lines long: pods elliptic-oblong, often obtuse, 1½–2 lines long, tipped by the minute style: fruiting raceme 2–6 in. long.—In the shade of sage-brush in early Spring.

C. Bursa-pastoris, Mœnch. SHEPHERD'S PURSE. Slender or the main stem sometimes stout, 6–18 in. high, branching chiefly from the base: "usually" somewhat hirsute and sparingly minutely stellate-pubescent below: leaves mostly a radical cluster, chiefly oblanceolate in outline, 2–4 in. long, dentate to pinnately parted with slender or rounded and toothed segments, the cauline lanceolate, sagittate, entire or dentate: flowers in a terminal cluster, 1–2 lines long: pods thin, cuneate, 3-lines long at maturity, retuse, the short style distinct: pedicels spreading slender, ½–¾ in. long: fruiting racemes 6 in. to 1 ft. long.—A cosmopolitan plant, probably introduced. Found in cultivated and waste places throughout Spring and Summer.

CAMELINA. Pods pear-shaped. Seeds incumbent.

C. sativa, Crantz. FALSE FLAX. An erect annual, 1–2 ft. high, with a stout root: branches rather rigid: hirsute, the inflorscence glabrous except the villous young sepals: leaves chiefly cauline, lanceolate auriculate-sagittate, clasping, entire or sinuately toothed, the lower 1–2 in. long: flowers in a terminal cluster, creamy-white, 1½ lines long: pods 2 lines or more long, narrow margined at the suture, tipped by the rigid style which is nearly a line long: pedicels spreading, ½–¾ in. long. —An introduced plant growing abundantly in neglected open places. Spring and Summer.

LEPIDIUM. Pod sub-orbicular, emarginately winged at the apex. Seeds one in each cell, mostly incumbent. Petals present or wanting. Stamens various.

L. intermedium, Gray. Annual, 6–18 in. high, erect and leafy, or spreading from the base and main stem, roughish, the pods glabrous: leaves 1–2 in. long, lanceolate, pinnately toothed to cleft or entire above: flowers minute in close terminal clusters; petals none; stamens 2: pods with the apex broadly rounded; pedicels not flattened, 2 lines long.—The commonest of our species occupying dry neglected lands and roadsides. Spring and Summer.

L. Virginicum, L. An annual, taller, with more open habit, finely hirsute below, the inflorescence puberulent with glabrous pods: lower leaves broadly lanceolate to elliptical-petiolate, 2–4 in. long, the upper linear, irregularly incisely serrate to dentate above: flowers closely clustered; petals 4, equalling the sepals, stamens 2: pods orbicular, often purple tinged; equalled or slightly exceeded by the slender cilindrical pedicels.—Common along roadsides during Summer.

L. alyssoides, Gray. Perennial, from an upright woody base; puberulent, often canescently so to almost glabrous: lower leaves frequently fascicled, erect, linear, pinnately divided into linear lanceolate segments, the upper pinnatifid to entire: flowers in rounded clusters; petals nearly 2 lines long, twice longer than the sepals, the limb broad and rounded; stamens 6: pods glabrous, reticulated, ovate, 1½ lines long, the emargination closed by the short, exserted style; pedicels slender, not flattened, twice longer than the pods.—Confined to moist sub-alkaline soil where it is found beneath grease-wood. May–Sept.

THYSANOCARPUS. Annual, slender. Pod orbicular, indehiscent, 1-celled, plano-convex, 1-seeded, wing-margined. Seed pendulous.

T. curvipes, Hook. Diffusely branched, 6–18 in. high; hirsute below, glabrous above, often more or less purplish tinged throughout: leaves broadly lanceolate below, 1–2 in. long, narrowed above, these entire or sinuately toothed, auricled, clasping: flowers minute, white: pod pubescent to glabrous, 3–4 lines in diameter, the margin crenate often perforated; pedicels slender.—Very plentiful in places on dry hills and among rocks. May, June.

CAPPARIDACEÆ.

CAPER FAMILY.

Ours all annuals with alternate, palmate or simple leaves, the latter dininishing upward as floral bracts. Flowers light yellow, perfect, hypogynous, the petals and stamens not always regularly inserted. Sepals or calyx diversions and petals 4 each, the latter oblong lanceolate. Stamens 6; ovary 1-celled with two parietal-placentæ. Style short. Pod stipitate. Seeds mostly smooth, folded.

* Pods longer than broad	CLEOME.
* * Pods of nearly equal length and breadth.	CLEOMELLA.

CLEOME. Leaflets 3–5, equalling the petiole except in the lowest leaves. Flowers in large terminal clusters. Petals 3–4 lines long. Stamens exserted. Pods pendent Stipe and pedicel about equal, ½–¾ in long.

C. platycarpa, Toor. Stout, erect, branching from below; pubescent, the stems glandular and heavy scented; pedicels and pods not glandular, the latter densely and finely pubescent, upper half of the stipe glabrous or nearly so: leaflets 3, an in. and less long, broadly oblong to lanceolate, ciliate: sepals subulate, nearly equalling the petals: pods flattened, broadly oblong, 6–9 lines long, the slender style a line long: seeds 10–12 in two rows.—Commonest on the foothills north of Reno, contributing largely to the floral display upon these hills in May and June of moist seasons.

C. lutea, Hook. Erect, 2–5 ft. high, branching widely, the main stem often 1½ in. or more thick, smooth or slightly pubescent in the inflorescence: leaflets 3–5, linear to lanceolate; 1–"2" in. long; calyx segments half the length of the petals: pods ¾–1½ in. long by 2 lines wide, not flattened, acute to the minute style, attenuate to the slender usually colored stipe: seeds in one row.—This species is confined at present to the railroads and their vicinities. It extends across the valley and grows vigorously. June–Sept.

CLEOMELLA. Glabrous. Leaves 3-foliate or simple, filamentous stipulate, leaflets and bracts setaceously tipped. Pods ovoid-triangular by the horned valves. Few seeded.

C. longipes, Torr. Erect, 6–18 in. high, branching below: leaflets elliptical-oblong to obovate, ½–1 in. long, much exceeded by the petiole in the lower leaves: flowers in a broad raceme on widely spreading pedicels; sepals minute, ovate, attenuate; petals 3 lines long; stamens exserted: pods 3 lines long and wide, style a line long; stipe ½ in. or more long equalling the pedicel.—Found on the foothills associated with the more common Cleome platycarpa. May, June.

C. parviflora, Gray. Spreading, 1–2 ft. high, the slender branches rather weak, often decumbent: leaflets 2–3 below, often reduced to one, linear-lanceolate, an in. or less long, exceeding the short petiole: flowers few at extremity of the branches, very small; petals 1–1½ lines long, stamens included; calyx minute with triangular segments: pods 2 lines long, the very slender pedicel ½–¾ in. long, declinate: stipe a line or less long; style minute.—Collected in September in a single saline locality in the southeastern part of the valley.

VIOLACEÆ.

VIOLET FAMILY.

Herbs, the corolla somewhat irregular and spurred, having 5 petals and 5 stamens. Style club-shaped. Ovary 1-celled with 3 parietal placentæ. Ovules several.

VIOLA. Sepals unequal as are the petals, the lower petal spurred at base. Anthers broad, nearly sessile, coherent. Perennials from a deep rootstock.

V. Beckwithii, Torr. and Gray. Stems very short from the deep rootstock: plant minutely pubescent or glabrous: leaves clustered, subterranean at base, remaining close to the ground, 3 times parted into many linear revolute segments ½ in. or more long: peduncles 3 or 4 in. long: flowers ¾ in. broad; petals yellow at base, the upper pair deep purple, the others violet, or occasionally white, the lateral pair bearded, the lower one often emarginate; style bearded at the side: capsule obtuse.—The common violet among sage-brush in April and May.

V. cucullata, Ait. From a thick branching rootstock with ample fibrous roots: smooth throughout: leaves with slender petioles 3–6 in. long, the blade reniform in the smaller, the larger cordate with broad sinus, acute at apex, 2 in. or more broad, with dentate-serrate margin: peduncles slender; flowers light to deep purple, 6–9 lines long, short spurred, the lateral petals bearded within.—Found in a few moist places. Taken by the author beside the Truckee near railroad bridge above Laughton's Springs and near Washoe City. June.

V. Nuttallii, Pursh. From a straight, woody fibrous rootstock, 3–6 in. high with several slender stems 1–2 in. long, these mostly underground: mostly villous pubescent above, often hoary: leaves ovate cuneate, sinuate-dentate, attenuate to the slender petiole: peduncles scarcely exceeding the leaves: flowers yellow, tinged with brown and purple, half an inch or less long, the spur short and thick.—On wild rocky and open land during May and June.

HYPERICACEÆ.

ST. JOHN'S-WORT FAMILY.

An order containing herbs and shrubs with opposite, entire leaves; these punctate with translucent, and often dark spots. Our representative belongs to

HYPERICUM. The free and distinct sepals and petals 5. Stamens many in 3 clusters. Styles 3. Ovary 3-celled. Flowers cymose.

H. Scouleri, Hook. Slender, erect from slender reddish rootstocks, 1–2 ft. high, glabrous: leaves ovate or oblong, 1 in. or less long, clasping: flowers pedicelled, in a loose cyme, bright yellow; sepals rounded 1–1½ lines long; petals oblong, 4 lines long: capsule 3-valved, many seeded, 2 lines long, surrounded by the persistent floral organs.—Generally found in damp and often shaded places, from June till August.

CARYOPHYLLACEÆ.

PINK FAMILY.

Herbs, ours without stipules, the parts of the calyx or sepals 5. Petals entire to 2-cleft, white or colored, the claw with or without an appendage. Stamens mostly 10. Ovary 1-celled with central placenta. Seeds several or many.

* Calyx tubular, toothed at apex.

Calyx cylindrical; petals bifid............................ SILENE.

Calyx wing angled; petals not bifid .... VACCARIA.

* * Calyx of distinct sepals.

Plant pubescent; capsule becoming cylindrical, hyaline; petals bifid...CERASTIUM.

Plant slender, smooth; petals bifid .. .. STELLARIA.

Plant low, closely bunched; leaves slender, rigid............ ARENARIA.

SILENE. Ours perennials. Styles 3. Petals bifid. Capsule becoming 6-toothed.

S. Menziesii, Hook. Perennial, 6–12 in. high, the slender week stems branching dichotomously, glandular-puberulent, with fine cobwebby hairs on the stems, especially above: leaves broadly lanceolate or spatulate below, acute, narrowed at base, 1–2 in. long: inflorescence spreading, leafy, the slender peduncles 1-flowered: flowers 3–4 lines long; calyx teeth short; petals white, exceeding the calyx, bifid with rounded lobes and narrow claw, without appendages.—In moist shaded places along the Truckee river and elsewhere. June.

S. pectinata, Watson. Perennial, from a thick root, stems one to several from the branched base, erect, strict, 1–2½ ft. high, very viscidly glandular-pubescent: leaves mostly radical, long petiolate lanceolate, 2–6 in. long, the cauline lanceolate or subulate, strict.clasping at base, upon long internodes: inflorescence a narrow several flowered panicle: flowers ½–¾ in. long; the calyx cleft nearly to the middle with narrow segments; petals rose-colored or purple, exceeding the calyx, with narrow appendaged claw and deeply bifid limb: capsule broad, 5 lines long: seeds dark, finely tubercled.—This plant is readily distinguished by its sticky surface, making the popular name "Catch Fly" most appropriate. Found among the foothills in June and July.

VACCARIA. Annual. Styles 2. Capsule, becoming 4-toothed. Seeds large, black.

V. vulgaris, Med. Cow Herb. Annual, glabrous throughout, light green 6–8 in. high, cymosely branched, leaves 2–3 in. long, lanceolate, acute, the broad base rounded or sub-orbicular: inflorescence an open dichotomous cyme: flowers slender pedicelled; calyx obtusely ovate ½ in. or more long, 5-toothed, 5-wing-angled; petals rose-colored to crimson, ¾ in. long expanded and somewhat jagged edged at apex: capsule ovate, surrounded by the dried calyx, becoming 4-cleft: seeds spherical, black.—An introduced weed common about the University from June to September.

CERASTIUM. Recognized by the exserted hyaline 10-toothed capsule.

C. nutans, Raf. Annual, with numerous slender stems erect or spreading, 6–18 in. high, cymosely branched; pubescent, glandular above: leaves broadly lanceolate, spatulate below, becoming minute above: inflorescence a many flowered open cyme, pedicels often reflexed: flowers 2–3 lines long, sepals scarious margined, acute; petals white, bifid, equaling the sepals, the matured capsules hyaline, twice longer than the calyx, cylindrical, curved, opening at the 10-toothed apex.—Found in moist places generally during Summer and Autumn.

STELLARIA. Very slender herbs, the delicate flowers long pedicelled.

S. longipes, Goldie. CHICKWEED. Perennial from creeping rooting stems, 3–6 in. high; stems slender, diffuse, erect or ascending, smooth, shining: leaves sessile, linear-lanceolate or subulate, ¾–1½ in. long: flowers slender, pedunculate solitary or few and cymose, 2 lines long, widely spreading, the sepals lanceolate, equaled by the white deeply cleft or parted petals: capsule ovate-oblong at length exceeding the calyx. Found during Summer in moist places, often in gardens as a common weed.

ARENARIA. Low tufted. Leaves rigid. Petals entire. Styles 3.

A. pungens, Nutt. Perennial from a deep root, matted, 3–6 in. high, stems numerous, becoming woody below, slender with short internodes, minutely glandular-pubescent throughout: leaves crowded, linear, rigid, pungent tipped, ½–¾ in. long, spreading recurved: flowers in an open cyme, leafy bracted, equaling the pedicels; sepals lanceolate pungently acuminate, scarious margined; petals white, about equaling the sepals, acute: capsule shorter than the persistent calyx.—Growing in patches on open ground among the hills north of Reno. May and June.

PORTULACACEÆ.

PURSLANE FAMILY.

Ours are more or less succulent herbs, somewhat diverse in habit, the flowers mostly delicate.

* Sepals 2.

Sepals united at base; flowers yellow .... PORTULACA.
Sepals distinct.
  Flowers white or rose-colored, loosely clustered .... CLATONIA.
  Flowers white, in compact spikes .... SPRAGUEA.

* * Sepals, 4–8.

Sepals imbricated; flowers showy, on jointed pedicels .... LEWISIA.

PORTULACA. Flowers solitary. Sepals united and adherent to the ovary below. Stamens 7–20. Capsule opening by a lid.

P. oleracea, Linn. COMMON PURSLANE, "PUSLEY." A smooth fleshy annual more or less tinged with purple: stems prostrate, weak, spreading a foot or more: leaves entire, an in. or less long, obovate or cuneate, the midvien prominent below: flowers sessile, light yellow, opening in the morning; calyx supporting the petals and stamens; style 5-6-parted; fruit transrcisely dehiscent: seeds very small, rough and black.—A very common garden weed in Summer.

CLATONIA. Flowers clustered. Sepals 2, distinct and free. Stamens 5. Capsule 3-valved

C. perfoliata, Donn. Annual with fibrous roots, succulent, green or tinged with pink or purple, 2–12 in. high: radical leaves, mostly spatulate with long petioles, exceeded by the slender stem, which is crowned by a single pair of leaves; these connate on one or both sides and subtending the sessile umbel-like raceme of several white or rose-pink flowers, which are 2 lines or more long; sepals exceeded by the oblong petals, which are united at base; style 3-cleft; capsule a line or more long: seeds 2–3.—A delicate plant of variable habit, growing in the shade of shrubs and rocks. May–July.

SPRAGUEA. Flowers in dense spikes, the 2 sepals free, distinct, unequal. Petals 4. Stamens 3, with colored anthers.

S. umbellata, Torr. Biennial from a short caudex; low, slender or the larger plants in compact rounded bunches 4–6 in. high; glabrous: leaves crowded, thick, succulent, 1–3 in. long, spatulate, peduncles numerous, scapose or with a few small leaves: flowers white, 4 lines broad, in crowded umbellate spikes; sepals scarious with greenish midvien, rounded, unequal, appressed; petals shorter, oblong; stamens with red or yellow anthers; style slender, bifid at apex; this with the stamens somewhat exserted; ovules 8–10: seeds lenticular, black.—An interesting plant found along the Gieger grade and at Steamboat Springs. April and May.

LEWISIA. Flowers showy. Sepals 4–8, distinct. Petals 8–16. Stamens many.

L. rediviva, Push. Perennial from a thick caudex with fleshy roots; 2–3 in. high. the clustered leaves smooth, linear-"oblong," 1–3 in. long: flowers several, conspicuous, on jointed scapes, these with 5–7 subulate scarious bracts at the joint: sepals imbricated, sub-hyaline, ½–¾ in. long, obovate-oblong: these with the scapes and anthers pink; petals 1–1¼ in. long, broad, cream-colored; stamens numerons; style 3-8-parted: capsule ovate, 4–5 lines high, 6-8-valved, dehiscing at the base, many seeded.—This strikingly beautiful plant is found growing in the hard soil among the sage-brush on the hills north of Reno. May and June.

MALVACEÆ.

MALLOW FAMILY.

Ours, herbs with mucilaginous juice, attenuate, stipulate, petiolate, pinnately veined leaves; often stellate-pubescent. Flowers often showy. Calyx valvate 5-cleft, with or without bractlets at the base. Petals 5, convulute, united at the base, adherent to the monadelphous stamens, which form a tube surrounding the style and crowned by the clustered, 1-celled anthers. The pistil a ring of carpels with one or two ovules in ours. Styles several, united at the base; stigmatic along the inner side *(i. e. lateral)* or at the apex *(i. e. capitate)*. Ours are perennials.

* Stamens lateral.

Bractlets 3; leaves lobed .... MALVA.
Bractlets none; leaves parted or divided .... SIDALCEA.

* * Stigmas capitate.

Ovules 2; flowers scarlet .... SPHÆRALCEA.
Ovules solitary; flowers smaller, creamy-yellow .... SIDA.

MALVA. MALLOW. Calyculate bractlets 3. Axis of the receptacle short, broad. Carpels numerous, 1-ovuled.

M. rotundifolia, L. COMMON MALLOW. Stems prostrate, a ft. or less long: smooth or sparingly finely pubescent; leaves cordate-rotund or reniform, long petiolate, obscurely 5-lobed, serrate or crenate: flowers whitish, purple tipped, ½ in. long, pedicellate, axillary: fruit depressed; carpels exceeded by the enclosing calyx. —A common introduced plant found along roadsides generally. June–Oct.

SIDALCEA. Calyculate bractlets none. Filaments in two series. Carpels few, covering the short axis of the receptacle, 1-ovuled.

S. malvæflora, Gray. Slender: few stemmed: minutely, sparingly and simply pubescent or "glabrous:" leaves long petiolate, mostly clustered at the branched base, circular in outline, 1–2 in. broad, more or less parted or divided into cuneate segments, these lobed or cleft, the segments narrower and simple above: flowers purple, solitary, in slender racemes, short pedicellate, ¾ in. long; petals emarginate; stigmas lateral; calyx segments acuminate, twice longer than the somewhat flattened fruit.—Confined to the foothills usually among shrubs and rocks. May–July.

SPHÆRALCEA. Calyculate bractlets 1–3. Stamineal column simple. Stigmas capitate. Carpels few, 2-ovuled.

S. Emoryi, Torr. Stems several from the base, prostrate or erect: densely stellate pubescent or glabrate; ashy or often hoary: leaves usually broadly 3-5-lobed, crenate or serrate, 1–2 in. long, equaling or exceeding the petioles: flowers short, pedicellate, crimson, ½–½ in. long; calyx slender bracteolate: fruit globose, densely pubescent: seeds 1 or 2.—The prostrate form is commonest upon the hills north of Reno, while the erect form occurs in the eastern portion of the valley and in the Virginia Mts. May–Oct.

SIDA. Calcyculate bractlets setaceous. Stigmas capitate. Carpels few. 1-ovuled. Leaves oblique. Flowers light.

S. hederacea, Torr. Stems several, decumbent to ascending, a ft. or less long; ash-grayish from a fine stellate pubescence: leaves semicircular and obliquely straight at base or sometimes reniform, serrate or sinuate, 1–2 in. broad: flowers solitary or panicled, cream-yellow (purplish in the bud), 4–6 lines long; petals oblique: pedicels at length reflexed: fruit rarely found, carpels 6–10, containing a single suspended seed.—This species is plentiful in restricted localities. Found in low places on hard soil about the Virginia and Sierra Nevada foothills. July–Sept.

GERANIACEÆ.

GERANIUM FAMILY.

The geranium family is here represented by two closely allied introduced genera, Erodium and Geranium.

* Leaves pinnate; petals entire........................ ERODIUM.
* * Leaves palmate; petals emarginate ....GERANIUM.

ERODIUM. Stamens 10, but 5 alternate longer ones fertile. Petals entire. Leaves pinnate.

E. cicutarium, L. Her. STORK'S BILL, ALFILARIA. Perennial from a thick deep tap-root, becoming much branched, the branches procumbent: hairy with an appressed pubescence in the inflorescence: leaves chiefly radical, 2–4 in. long, pinnate, the segments once or twice pinnatifid or pinnately parted; stipules thin, triangular or rounded: flowers rose-pink, 3–7 umbellate on slender peduncles; petals 2½–3 lines long, exceeding the sepals; the fertile and sterile stamens alternating; ovary 5-celled, cells 2-ovuled, the single style crowned by the 5-lobed stigma: fruit erect upon the reflexed pedicel, the elongated style 1–1¼ in. long; carpels with a twisted awn, 1-seeded. —Very common everywhere; flowering from earliest Spring till late Autumn.

GERANIUM. Stamens 10, 5 alternate ones shorter, fertile or sterile. Petals emarginate. Leaves palmately parted.

G. pusillum, L. CRANE'S BILL. Stems procumbent, slender: finely pubescent throughout: leaves rounded or orbicular, an in. or more broad on long slender petioles, 5–9 palmately parted, the segments variously cleft: peduncles short, axillary, bearing two umbelled pink flowers; petals exceeding the sepals, slender at base, emarginate, 2 lines long; style short; stigmas 5, slender:

fruit with the elongated style ½ in. long.—A few specimens of this species have been found on the University lawns, where the seed was introduced with grass seed. Flowering during Summer.

LEGUMINOSEÆ.

PULSE FAMILY.

Ours, belonging to the Papilionaceous division, have irregular flowers. Calyx 5-cleft or shorter-toothed, of equal or unequal segments. Corolla of 5 petals (composing the "standard," "wings" and "keel"). Stamens and pistil within the keel, the former 10 and monadelphous or diadelphous. Style usually incurved. Stigma simple. Legume 1-celled or falsely 2-celled. Leaves in ours digitate or pinnate.

* Anthers of two forms; stamens monadelphous.

Leaves digitate, of more than 3 leaflets .... LUPINUS.

* * Anthers uniform; stamens diadelphous.

Leaves digitate or pinnate, of 3 (5–7 in one Trifolium) leaflets.
  Flowers capitate; leaves digitately 3-foliate (5-7-foliate in one.. TRIFOLIUM.
  Flowers in racemes; leaves pinnately 3-foliate; pod curved or spiral .... MEDICAGO.
  Flowers in racemes; leaves pinnately 3-foliate; pod small, obovoid .... MELILOTUS.
  Flowers solitary, axillary; leaves pinnately 3-foliate; pods linear .. .. HOSACKIA.
Leaves pinnate, of several leaflets.
  Pod more or less turgid, pubescent or smooth ....ASTRAGALUS.
  Pod thin, smooth; leaves terminated by a branched tendril.. LATHYRUS.

LUPINUS. LUPINE. Ours with flowers in a raceme. Leaves 5-12-foliate, leaflets entire. Calyx bilabiate. Standard broad, its edges reflexed. Anthers of two kinds, alternately oblong and rounded.

* Annuals.

L. pusillus, Pursh. Annual, 3–6 or 8 in. high, simple or branching from the base: pubescence softly villous, spreading: leaflets lanceolate or oblanceolate, mostly 5–7; stipules and floral bracts setaceous: peduncle 2–3 in. long; raceme spike-like, elongating in age: flowers mostly verticillate, pedicelled, ½ in. long, white, cream-colored or bluish: pod thin, ½ in. or more long, mostly 2-seeded. —Common, often in patches. May, June.

L. brevicaulis, Watson. From 2 to 4 in. high, older plants with many short stems; lightly villous, the stems sparingly so: leaflets cuneate-obovate, entire to emarginate at apex, ½–¾ in. long: peduncles 1–2 in. long; racemes several flowered, less than an inch long: flowers bright blue, ¼ in. or less long. crowded: pods 4–6 lines long, 2-3-seeded.—Generally in sandy places. May, June.

* * Perennials.

L. confertus, Kell. Rather stout, usually densely tufted, 12–18 in. high: herbage deep green: pubescence densely silky-villous, mostly appressed, somewhat slightly spreading: leaflets rather broadly oblanceolate, tufted, mucronate tipped: racemes 3–6 in. long: flowers mostly verticillate, bright purple, nearly equaled by the persistent bracts: pod ½ in. or more long, 2-4-seeded. —Foothills. May–Aug.

L. lepidus, Dougl. Structurally similar to the last: slenderer, not tufted: herbage lighter green: pubescence finer: raceme usually shorter: flowers violet.—Less common than the last and to be distinguished from it by the lighter herbage and flowers, and slenderer habit. May–Aug.

L. calcaratus, Kell. Woody at base with erect or ascending branches, 1–2 ft. high: silvery canescent from a fine appressed pubescence: leaflets 6–12, narrowly lanceolate, 1–2 in. long, the petiole at least twice longer:

flowers 4–6 lines long, white, bluish or purple, in a rather open raceme 3–6 in. long, pedicelled; the calyx spurred at base, the banner externally pubescent: pods ½–1 in. long, white, pubescent: seeds white, 2–3 lines long.—Among the sage-brush, chiefly on the foothills. May–July.

TRIFOLIUM. Leaves 3-palmate, except in the first. Flowers capitate-clustered. Calyx about equally 5-cleft. Corolla persistent, withering, soon turning brown. Stamens usually diadelphous. Seeds 1–6.

* Heads without involucre.

T. megacephalum, Nutt. Perennial from a strong deep root: stems sub-erect, 6–8 in. long: finely villous: leaflets 5–7, 1–¾ in. long, cuneate-obovate, dentate; stipules leafy: heads peduncled, terminal, large, 1–1½ in. broad, dense: flowers nearly an in. long, pink-purple, lighter at base; calyx teeth very slender, plumose, 5 lines long: pod stipitate, 6-seeded.—Dry ground, southwest of Reno. May.

T. pratense, Linn. RED CLOVER. Perennial, stems ascending: from glabrous to soft villous: leaves slender, petioled, stipules bristle-tipped; leaflets an in. or more long, mostly ovate, nearly or quite entire: heads sessile, oval, an in. or less high: flowers pinkish-red.—Common throughout Summer.

T. repens, Linn. WHITE CLOVER. Perennial from slender creeping stems, smooth: leaflets rounded, often obovate, dentate ½–¾ in. long on long slender petioles: heads ½–¾ in. broad, crowning long slender axillary peduncles: flowers white, small; pedicels usually partly reflexed.—Common in lawns during Summer.

* * Heads with an evident involucre.

T. involucratum, Willd. A slender perennial with rather weak rooting stems, found in damp or wet places:

smooth: leaflets oblanceolate to oblong, ½–¾ in. long, sharply serrately toothed: peduncles axillary, 2–3 in. long; involucre many and laciniately cleft; heads ½–¾ in. broad, rose-colored to purple: flowers 4 lines long; calyx teeth about equaling the tube, slender and gradually pointed, the mid-nerves of the segment prominent: pod 4-6-ovuled. Very common along ditches throughout Summer.

T. tridentatum, Lindl. Somewhat resembling the last in the appearance of the heads: it is, however, more erect, stouter, usually finely pubescent, and does not root at the branches: the calyx strongly and equally veined, the teeth abruptly pointed: ovules 2.—Found in sandy places in Summer.

T. cyathiferum, Lindl. An annual with erect spreading stems, a foot or less high, smooth: leaflets oblanceolate to oblong, ½–¾ in. long; peduncles 2–3 in. long: involucre conspicuous, ½ in. high, lobed and toothed: heads nearly included: corolla "rose-colored," equaled by the calyx, the teeth of which are branched: pod 2-seeded.—In sandy places in Summer.

MEDICAGO. Flowers similar to those of clover, close racemed. Leaves pinnately 3-foliate, petioled below, nearly sessile above. Stems somewhat angled.

M. sativa, Linn. LUCERNE ALFALFA. Perennial from a deep tap-root, erect, 1–3 ft. high, appressed-pubescent or "glabrous:" leaflets ½–1 in. long, narrowly cuneate-obovate to oblanceolate, sinuate-dentate toward the apex, mucronate; stipules attenuate, veined: racemes an in. or less long: flowers blue or purple, 4 lines long: pods spirally coiled, 6–10 seeded. June–Oct.

M. lupulina, L. BLACK MEDICK. "Biennial or perennial:" stems slender, procumbent, 1–2 ft. long:

finely silky-villous: leaflets ½ in. long, cuneate-obovate or broadly so, dentate above the middle, mucronate; stipules lanceolate, dentate, veined: peduncles slender: flowers in a small crowded cluster, yellow, scarcely more than a line long: fruiting racemes ½–1 in. long: pods reniform, 1-seeded, black at maturity.—In lawns and meadows. June–October.

MELILOTUS. Flowers similar to those in Trifolium. Pod short, exceeding the calyx. Stipules linear. Leaves pinnate, 3-foliate.

M. alba, Lam. WHITE MELILOT, SWEET CLOVER. Biennial or perennial, 3–6 ft. high, with spreading branches, smooth or slightly pubescent; leaflets cuneate-oblong or obovate, ¾–1½ in. long, serrate, dentate, entire at base: racemes slender, 3–5 in. long: flowers white, 2 lines long; the standard exceeding the other petals: fruit obovoid. 1½–2 lines long, pendent, tipped by the slender style: 1–2 seeded.—Very common along ditch-sides throughout Summer and Autumn.

M. officinale, Willd. YELLOW MELILOT. Annual or biennial, very similar to the last: usually but 2 or 3 ft. high with yellow flowers, the petals nearly equal: the racemes usually shorter.—But a few specimens have been found within our range.

HOSACKIA. Calyx teeth nearly equal. Stamens diadelphous. Anthers uniform. Leaves pinnate, the stipules mere glands. Peduncles axillary, solitary, with a single leaflet at apex.

H. Purshiana, Benth. Annual, erect, slender when young, becoming much branched: silky-villous, or "sometimes glabrous," often canescent: leaves nearly sessile; leaflets 3 or mostly one above, ovate to lanceolate, ½–1 in. long: peduncles exceeding the leaves: flowers about 3 lines long, very short pedicelled; calyx deeply cleft into narrow segments, nearly equaling the corolla, which is cream-colored, the standard tinged with pink: pod linear, straight, glabrous, an in. or less long, 5-7-seeded: seeds oblong, mottled.—A common, rather variable plant. July–Sept.

ASTRAGALUS. Calyx 5-toothed. Corolla and petals narrow. Stamens 9 and 1; anthers uniform. Leaves unequally pinnate. Pod various, important in classification. Ours all perennials.

* Pod woolly or long-hairy.

A. Purshii, Dougl. Low, tufted, 3–6 in. high, spreading, stems slender, soft, silky-villous with appressed hairs, canescent, and somewhat tomentose in specimens from saline soils: leaflets 7–"19," oblong to oblanceolate, 3–5 lines long: peduncles few flowered, equaling, but slightly exceeding the leaves: flowers spreading or ascending, nearly an in. long; calyx cylindrical, the short subulate teeth less than half the length of the tube; corolla nearly twice the length of the calyx, bright-purple or white and purple tipped: pods conspicuous, densely white or yellowish woolly, ¾ in. long, becoming incurved, pointed.—On hard wild land and at Steamboat Springs. May, June.

A. malacus, Gray. Erect or ascending from a stout branched base, 6–15 in. high, densely white-villous, with long spreading hairs; stems rather stout, often purplish: leaflets 11–17, obovate to elliptical-oblong, entire or "retuse:" peduncles surpassing the leaves: the close floral spike elongating with age to 2 in. long, dark hairy: calyx cylindrical, teeth slender, half the length of the tube; corolla a half longer than the calyx, deep purple: pods an in. long, ¼ in. wide, spreading, upward curved, acute, grooved dorsally, ventral edge thin, more or less mottled.—Common in May and June on dry land among sage-brush.

A. Andersonii, Gray. From a branched base, 6–10 in. high, pubescence canescent, short, silky: stems slender, decumbent and woolly at base: leaflets 13–21, 4–6 lines long, elliptical with acute base: peduncles exceeding the leaves: flowers spreading in a slender or compact raceme, ½ in. long; corolla yellowish-white, often tinged with blue or purple, twice longer than the bell-shaped calyx; calyx teeth subulate-setaceous, nearly equaling the tube: pods spreading or pendulous, upward curved, 5–7 lines long, somewhat flattened, tipped by the setaceous style: fruiting racemes 2–4 in. long.—Very common among the sage-brush. May, June.

* * Pods with fine appressed pubescence, or nearly smooth.

A. obscurus, Watson. Very slender, a ft. or more high, minutely appressed-pubescent, often cineraceous: leaflets 9–15, elliptical to linear-oblong, 3–5 lines long; peduncles exceeding the leaves, several flowered at the apex: flowers 4 lines long, light yellow, calyx 2 lines long, teeth short and slender: pods erect, an in. or more long, 2 lines broad, straight or curved, extremities acute, grooved dorsally, the ventral suture prominent.—Found in dry rocky places among sage-brush. May, June.

A. Mortoni, Nutt. Erect, 12–18. in. high; pubescence minute, closely appressed: leaflets 15–23, oblong or obovate, ½ in. long, obtuse or emarginate: peduncles scarcely exceeding the leaves: flowers in a close spike, reflexed, creamy-yellow, or sometimes greenish tinged, including the calyx, 7–9 lines long; calyx 4–5 lines long, broad, ventrally saccate at base, the teeth short, triangular: pods erect, ½ in. long, incurved; the acute tip recurved, dorsally grooved, the ventral suture prominent: fruiting spike dense, 2–3 in. long.—Most abundant upon moist, natural grass land. May, June.

A. iodanthus, Watson. Stems numerous, at length procumbent; dark green, sparingly and minutely appressed-pubescent, or nearly glabrous: leaflets 15–21, ovate to oblong, obtuse or retuse, ½ in. long, peduncles numerous, not exceeding the leaves, several flowered: flowers deep violet-purple, often some yellowish-white ones present; corolla 6–8 lines long; calyx 3 lines long, dark pubescent, the subulate teeth a line long: pods curved, finally to a semi-circle and ob-compressed, an in. or more long, acute, almost glabrous and usually mottled.—Common within our range, chiefly confined to the hills, May, June.

LATHRYRUS. Calyx unequally 5-toothed. Style flattened, hairy at the tip. Leaves pinnate, terminating in a 3-branched tendril.

L. palustre, Linn. Perennial, slender, 2–3 ft. high; stems weak, usually narrowly wing-angled, very finely pubescent, or glabrous; stipules usually slender: leaflets 4–6 pairs, variable, entire, oblong or narrowly so, lanceolate or linear, ¾–1½ in. long, mucronate: flowers few or several, in a loose raceme, ¾ in. long, the calyx 2–3 lines long, petals mostly light-purplish or violet tipped: pods thin, glabrous, acute at both ends, 1–1¼ in. long by 4 lines broad: seeds sub-globose, brown.—The so-called "Wild Pea," found in moist and shaded places. June–Sept.

ROSACEÆ.

ROSE FAMILY.

Herbs, shrubs or trees. Leaves alternate, mostly stipulate. Stamens usually numerous. Carpels one to many, free and distinct in ours.

* Shrubs.	
Low; carpels 3–5, becoming follicles; flowers purple	Spiræa.
Often tree-like; carpel solitary; flowers white or rose-colored	Prunus.
Coarse; carpel solitary; flowers yellow	Purshia.
Erect; carpels several; calyx contracted; flowers showy.	Rosa.
* * Herbs, with yellow flowers.	
Carpels numerous; leaves 3-5-digitate	Potentilla.
Carpels few; leaves pinnate, with many small leaflets	Ivesia.

SPIRÆA. Meadow-Sweet. Calyx teeth and petals 5. Stamens many. Carpels 5, free, distinct, becoming several seeded follicles.

S. betulæfolia, Pallas. Shrubby, 1–2 ft. high, with smooth stems and reddish bark: leaves erect, simple, 1–1½ in. long, ovate to oblong, acutely serrate except at the base, the short petioles minutely pubescent: flowers purple in a conspicuous compound corymb 2–3 in. in diameter; calyx tube cup-shaped, a line broad; the oblong petals a line long; carpels a line long, the slender style expanded at the simple stigma.—Along streams in the Sierra Nevada foothills in June and July.

PRUNUS. Plum, Cherry, etc. Calyx 5-lobed or -cleft. Petals 5. Stamens 15–25, inserted with the petals on the calyx. Ovary solitary. Fruit fleshy, with a bony stone.

P. demissa, Walp. Wild Cherry. Shrubby or tree-like; leaves 1–3 in. or more long, slender petiolate, lighter beneath than above, smooth or sometimes slightly pubescent along the venation, finely and sharply serrate, lanceolate to acutely oblong, the larger usually broadest above the middle, usually with a pair of glands on the petiole at the base of the blade: racemes 2–4 in. long, leafy below: flowers 1½ lines broad; calyx 5-lobed; petals white, a line long and broad; stamens 20: fruit blue-black or reddish, ¼ in. broad, thin skinned.—The common "Choke Cherry" found along the Truckee river. Flowering in May and June. In fruit in Aug. and Sept.

P. Andersonii, Gray. Shrubby, 2–8 ft. high, the spinescent branches diffuse, bark gray or reddish: leaves and flowers clustered upon short branchlets from the spines: leaves ½–¾ in. long, lanceolate, serrulate, attenuate to a short petiole: flowers showy and fragrant; pedicels and calyx reddish, calyx teeth short; the oblong petals 4–5 lines long, rose-colored to light pink; ovary woolly, style slender: fruit velvety, flattened-globose, ½ in. or more long, the thin flesh splitting at maturity.—Common. Flowering in Apr. and May. Fruiting in July and Aug.

PURSHIA. Calyx persistent, 5-lobed. Petals 5. Stamens about 25, in one row. Pistil a solitary carpel.

P. tridentata, DC. A coarse shrub with strong branches, usually 2–5 ft. high: leaves clustered on short branchlets, triangular-obovate, with narrow base, ½–1 in. long, 3-lobed at apex, white tomentose below, greener above: flowers yellow, pubescent, sessile, at the extremities of the branchlets; calyx ¼ in. long; petals cuneate-obovate, ¼ in. long; style stigmatic along the side: fruit finely pubescent, ½ in. long, fusiform, bitter to the taste: seed solitary, erect.—Frequent on the foothills in May; fruiting in June.

POTENTILLA. Five-Finger. Calyx persistent, 5-lobed to parted with 5 alternate bractlets. Petals 5. Stamens 10 or 20 in ours. Carpels 10 or more, with slender styles. Leaflets 3–5, digitate in ours.

P. millegrana, Watson. Annual or biennial, 1–2 ft. high, the few or several stems erect, finely and softly somewhat glandular pubescent: leaves 3-foliate, the lower long petiolate, leaflets more or less cuneate with rounded lobed or cleft apex: inflorescence cymose, close, somewhat leafy: flowers 2 lines broad; the segments of the 5-pointed calyx nearly equaled by the narrow bractlets; petals yellow, but a line or more long, oblong; stamens 10, 2 opposite each calyx segment: akenes numerous, whitish.—In moist and shaded places. June-Sept.

P. gracilis, Dougl. Perennial, with rather stout erect or weak stems; 2–3 ft. high; villous, or the older stems but slightly so, the inflorescence canescent: leaves 5-7-foliate, the slender leaflets 2–3 in. long, serrately lobed or cleft: flowers short pedicellate, 4–6 lines broad; the narrow bractlets shorter than the lanceolate calyx segments; petals yellow, broadly obovate, 3–4 lines long; stamens 20; akenes numerous.—In moist meadows and along ditch-sides. June–Sept.

IVESIA. Having much the aspect of Potentilla. Leaves pinnate, with numerous small leaflets.

I. Pickeringii, Torr. Slender from a thick caudex, which is usually crowned by a thick fascicle of dried stems and leaves; more or less canescently soft silky-villous: stems erect, closely panicled above: leaves slender, the radical 4–8 in. long; leaflets closely imbricated, entire and acutely oblong, or 2-5-lobed or -parted: flowers rather closely clustered, 3–4 lines long; the 5 slender tipped calyx segments alternated by shorter narrowly lanceolate bractlets; petals yellowish, narrowed at the base, scarcely equaling the calyx; stamens 20; carpels 3–6, styles slender.—Occurring along the base of the Sierra Nevadas in June.

ROSA. Rose. Calyx globose, enclosing the 10–25 hairy 1-seeded carpels, contracted at the throat. Petals 5, conspicuous, spreading. Stamens many on the calyx. Stems prickly. Leaves pinnate. Fruiting calyx red.

R. californica, var. **ultramontana,** Watson. A shrub 4–8 ft. high, younger stems reddish, prickles slender, numerous, scattered below, mostly in pairs below the leaves and branchlets above: leaves 3–6 in. long, minutely pubescent; leaflets 7–9, elliptical-oblong, ½–¾ in. long, serrate except at base: flowers short pedicelled in close clusters; pedicels and calyx tube glabrous; calyx segments acuminate, 3–4 lines long, tomentose at the edges and within; petals broad, ¾ in. long: fruiting calyx ¼–½ in. long; the carpels hard, light colored.—The common wild rose, flowering in Summer.

SAXIFRAGACEÆ.

SAXIFRAGE FAMILY.

Herbs, shrubs or trees, differing from Rosaceæ in having a definite number of stamens; commonly exstipulate leaves; and a compound ovary. Petals and stamens perigynous.

RIBES. Currant, Gooseberry. Calyx adnate to the globose 1-celled ovary, 5-cleft. Petals erect, 5. Stamens 5, alternate with the petals. Fruit a many seeded berry. Placentæ 2, parietal.

R. aureum, Pursh. A shrub, 3–6 ft. high, with grayish bark: smooth or minutely pubescent on the slender petioles and in the racemes except the pedicels:

leaves short, rounded at base, palmately veined, 3-5-lobed or -cleft and few toothed: flowers bracteate, short racemed; calyx tubular, 5 lines long, yellow, the lighter petals shorter than its lobes; style slender; stigma capitate: berry smooth, the size of a small pea.—Flowering in May, fruiting in June.

ONAGRACEÆ.

PRIMROSE FAMILY.

Herbs, flowers often showy and fragrant. Parts of the flower in fours. Calyx tube slender or short. Leaves simple, entire to divided, opposite or mostly alternate.

* Seeds comose at apex.

Flowers small; capsule linear .... EPILOBIUM.

* * Seeds not comose.

Delicate annuals with minute flowers .... GAYOPHYTUM.

Calyx with linear or obconic tube; flowers larger, often showy .... ŒNOTHERA.

EPILOBIUM. WILLOW-HERB. Calyx 4-parted to the ovary, or scarcely so in the first. Petals 4. Stamens 8, 4 alternate ones shorter. Stigma oblong, except in the first. Capsule 4-celled. Seeds comose.

E. spicatum, Lam. Perennial 2–4 ft. high, slender, erect: puberulent, flowers and capsules canescent: leaves sessile with narrow base, lanceolate, entire or sparingly denticulate, 3–6 in. long: flowers racemed, conspicuous, purple; petals spreading, rounded, short clawed, ½ in. long; calyx tube none; sepals narrow, reflexed; stigma with linear lobes: capsule 1–2 in. long, attenuate to a slender pedicel.—In restricted moist, often shaded, places. June–Aug. An apparent variety found above Laughton's Springs has smaller flowers, linear leaves, and sessile, broader capsules.

E. coloratum, Muhl. Perennial, stems rooting, 6 in.–2 ft. high, branching, mostly glabrous with a fine pubescence above, often reddish tinged: leaves mostly opposite, short petioled, 1–2 in. long, lanceolate, sinuate-denticulate, somewhat decurrent above: flowers short pedicelled, 2–3 lines long, white or pink; calyx tube a line long; petals 2-lobed or -cleft: capsules linear, 4-sided, erect, 2–2½ in. long; pedicels ½–1 in. long.—Along streams generally. June–Nov.

E. paniculatum, Nutt. Annual, mostly simple, erect, paniculate above, 1–5 ft. high: glabrous or occasionally somewhat pubescent: leaves linear-lanceolate, 1–3 in. long, usually folded, the base slender, subulate above: flowers scattered, mostly pink; calyx tube a line or more long; petals 3 lines long, 2-cleft: capsules about an in. long, linear, tapering at each end, straight or curved, short pedicelled.—A common way-side plant flowering during Summer.

ŒNOTHERA. PRIMROSE. Calyx tube prolonged beyond the ovary, the segments reflexed. Petals 4, broad, usually becoming pink or red with age. Stamens 8. Stigma lobed or capitate. Capsules various, important in classification. The more conspicuous flowers opening chiefly in morning and evening.

* Calyx tube linear above the ovary.

Œ. biennis, Linn. EVENING PRIMROSE. Biennial, stout, erect, 2–5 ft. high, simple or branched at base; finely pubescent or partially hirsute, somewhat canescent: leaves simple, denticulate or entire, lanceolate, the lower 6–12 or 15 in. long with slender margined petiole, becoming sessile above: flowers sessile, axillary, showy, petals yellow, 1–1½ in. long; calyx tube slender, 2–3 in. long; stigma lobes linear: capsule about an inch long, oblong, obtusely angled, erect.—Common in moist places from July to September.

Œ. cæspitosa, Nutt. Perennial, close tufted, 6 in. to a foot high, stems short, from a deep stout root: more or less hoary with a thick villous pubescence, which conspicuously fringes the leaves: these numerous 6–12 in. long, lanceolate, irregularly sinuate toothed or cleft: flowers showy, fragrant, expanding 3–4 in., white or rose-colored; calyx tube 4–6 in. long; stigma lobes linear; bud sub-conical: capsule ½–2 in. long, oblong-acute, or ovate-attenuate, tubercled between the sutures, sessile or short stemmed.—A conspicuous plant in sandy places in May and June.

Œ. triloba, Nutt. Annual or biennial, with the habit of the last, but usually much smaller, light green, the stems often purplish, glabrous or minutely pubescent: leaves 3–6 in long, spatulate-lanceolate or lanceolate, entire or sinuate, to pinnately parted or divided: flowers white or cream-colored, generally smaller and more pleasantly fragrant than the preceding, 2–3 in. expanse, usually rose-colored; calyx tube slender, 2–3 in. long; stigma lobes linear; the bud oblong, 4-angled: capsule broadest at base.—Associated with the last, but less common.

Œ. Nuttallii, Torr and Gray. Biennial or perennial; low, acaulescent, minutely and densely pubescent, leaves numerous, spreading, petioled, slender, 4–6 in. long, irregularly, pinnately parted or divided, the segments more or less toothed: flowers light yellow; calyx tube very slender, 2–3 in. long, abruptly expanded beneath the petals, which are ½–¾ in long; stigma capitate: capsule "slender, attenuate, 6–10 lines long, obtusely 4-sided, rarely developed."—Along ditches and in the vicinity of moist places during Summer.

Œ. heterantha, (?) Nutt. Apparently biennial, very similar to the last in general appearance: glabrous: leaves thin, 4–6 or 8 in. long, mostly slender, sinuately pinnately parted into narrow dentate segments, sinuately dentate or entire at apex: flowers yellow; calyx tube slender, gradually expanding toward the apex, 2–3 in. long; segments commonly remaining united, producing a hood-like appearance; petals ½–¾ in. long; stigma linear lobed: capsules oblong, acute, strongly 4-winged, smooth, ¾ in. long, often pinkish, clustered.—In wet places. June–Aug.

* * Calyx tube short (obconic) above the ovary, stigma capitate.

Œ. dentata, Cavanilles. A diffuse annual, 6–12 in. high; mostly densely hirsute below, glandular above; stems often reddish-purple: leaves slender, ½–1½ in. long, dentate: flowers axillary, yellow, soon becoming reddish; petals 2 lines long; calyx tube a line long: capsules narrowly linear, obtuse, obscurely 4-angled, 1–1½ in. long.—Common in sandy places, May, June.

Œ. alyssoides, Hook. and Arn. Annual; from an inch or so high to spreading, the decumbent or procumbent stems 3–12 in. long: smooth, with fine appressed pubescence in the inflorescence, often reddish: leaves 1–3 in. long, spatulate to linear-lanceolate, slender petioled, clustered with the white flowers at the extremities of the branches: petals 2–3 lines long: capsule ½–¾ in. long, attenuate, tortuous, angled, sessile.—In dry places, often in patches on the foothills. May, June.

Œ. scapoidea, Nutt. Annual; erect, simple or branched near the base; 12–18 in. high: glabrous: leaves 2–4 in. long; lyrate-pinnate; the terminal leaflet much the largest; ovate to lanceolate, sinuate-toothed; lateral leaflets small, few, or none, petiole slender: raceme nodding at first; bracts leafy below: flowers yellow: petals sub-orbicular, 3 lines broad; calyx tube 2 lines long: fruiting raceme 3–8 in. long: capsule linear-oblong, 6–9 lines long, straight or curved on nearly equal pedicels.

Plant rather variable in respect to the flowers, capsules, and pedicels; sometimes puberulent.—Common on the hills, May–July.

GAYOPHYTUM. Annuals with minute flowers (but a line long). Petals 4. Calyx not produced beyond the ovary. Stamens 8. Stigma capitate. Plants mostly smooth, with loose bark at base.

G. ramosissimum, Torr. and Gray. 6–12 in. high, diffusely branched, the branches becoming filamentous; glabrous or puberulent with slight appressed pubescence in the inflorescence: leaves linear or mostly lanceolate, ½–1½ in. long: flowers white or sometimes rose-colored: capsules 2–2½ lines long, obtuse, equaling or shorter than the slender pedicels; few seeded; often reflexed.—In patches on dry land among sage-brush in Spring.

G. racemosum, Torr. and Gray. Very similar to the last, but generally coarser: 6–18 in. high, usually with a fine appressed or spreading pubescence: leaves often 2 in. or more long: flowers often larger, usually rose-colored: mature capsules 5–6 lines long, tapering at base to a slender or very short pedicel: seeds numerous.—Distinguished by its coarser habit and slenderer capsules. Found in sandy places, Sierra Nevada foothills, during Summer.

LOASACEÆ.

LOASA FAMILY.

Rough herbs. Floral organs at the apex of the 1-celled ovary. Placentæ parietal. Stamens usually numerous.

MENTZELIA. Ovary nearly cylindrical. Calyx of 5 teeth. Petals 5, yellow. Style 3-cleft. Leaves sinuately toothed or pinnatifid, or even entire.

* Annuals.

M. albicaulis, Dougl. 6–12 in. high, branching at base; lower leaves slender, mostly pinnatifid, the segments slender, obtuse: flowers clustered at the ends of the branches; petals about 2 lines long, light yellow, obovate: capsule 5–7 lines long, cylindrical, narrowest at base, truncate and tipped by the calyx teeth; somewhat hirsute.—Very common. May–July.

M. gracilenta, Torr. and Gray. Very similar to the last. It is, however, generally stouter with coarser leaves: flowers larger, brighter, the petals 3 lines or more long, deep orange at base: capsules more hirsute. —Associated with the last and very common.

* * Biennial.

M. lævicaulis, Torr. and Gray. Stout, 2–4 ft. high; very rough; first year leaves 6–10 in. long, sinuately and obtusely lobed or pinnatifid, thick, leafy throughout: flowers showy; calyx teeth acuminate, an in. long; petals lanceolate, 2 in. long, deeper yellow within than without; stamens very numerous, often a few petaloid: capsule 1–1½ in. long.—In places along the Truckee river. July–Sept.

UMBELLIFERÆ.

PARSLEY FAMILY.

Ours low, perennial herbs. Flowers small, in an umbel or head. Stamens and petals 5 each, epigynous. Calyx teeth 5 at the apex of the 2-celled ovary. Styles 2, with an enlargement at the base. Ovules one in each cell.

* Flowers in compound umbels.

PEUCEDANUM. Stem short, subterranean. Leaves finely and mostly tri-pinnately dissected. Petioles sheathing at base, 3–6 in. long. Flowers small. Umbel crowning a simple scape. Petals a line long. Involucre none. Plants 3–6 in. high on hard ground. Perennials.

P. nevadense, Watson. Glaucous, puberulent: rays of the umbel unequal: involucel bracts usually united with only the tips free: flowers white with purple anthers.—One of our earliest Spring plants, flowering by March 1st, disappearing in May. Commonly called "Pepper and Salt."

P. villosum, Nutt. Very similar, smooth to finely pubescent, more open in habit: rays of the umbel more nearly equal: involucel of narrow distinct bracts: flowers yellow.—Common, appearing later than the last, which it replaces in the hills.

* * Flowers in a dense globose head.

CYMOPTERUS. Perennial from a thick vertical root. Low.

C. globosus, Watson. Nearly or quite stemless: smooth: leaves flattened, bi- or tri-pinnately compound, the segments rather broad; blade 2 in. long, lying on the surface of the ground; peduncles slender, 3–5 in. long: flowers white, in a campact globular head ½–¾ in. in diameter.—Growing in sandy places. Apr.–May.

VALERIANACEÆ.

VALERIAN FAMILY.

Herbs with opposite leaves. Ovary inferior, with but one complete cell. Corolla tubular, 2-lipped. Calyx apparently none.

VALERIANELLA. Corolla 5-lobed and 2-lipped, bearing a spur on the side. Stamens 3, on the corolla.

V. congesta, Lindl. A succulent annual, 6–12 in. high; glabrous; branching sparingly, or not at all: stem 4-angled: leaves sessile, elliptical-oblong, folding outward: flowers white to rose-colored in a terminal oblong cluster: floral bracts slender: ovary depressed on one side: corolla 1–2 lines long; anthers reddish: fruit akene-like. —In shade of sage-brush and rocks. Apr.–May.

COMPOSITÆ.

COMPOSITE FAMILY.

Herbs. Flowers in a true head upon a common receptacle surrounded by one to several series of bracts *(involucre)*. Bracts often occurring at the base of the individual flowers *(chaff)*. Calyx appearing at the apex of the 1-celled ovary as fine bristles, paleæ or awns *(pappus)*, or sometimes absent. Corolla upon the ovary, either tubular and usually 5-lobed, or strap-shaped *(ligulate)*, and from entire to 5-toothed at apex. Stamens 5, upon the corolla, the anthers united *(syngenesious)*. Style 2-cleft, the branches in the perfect tubular flowers stigmatic usually at the base with a more or less hairy tip or "appendage" above. Tubular flowers usually perfect. Ligulate flowers perfect when they constitute all of the head. Heads consisting wholly of tubular flowers are *discoid*; consisting of both tubular and ligulate flowers are *radiate*; and wholly of ligulate flowers are *ligulate*.

An understanding of the character of the pappus is necessary in the employment of the following key to the genera.

Series I. TUBULIFLORÆ. At least a part of the flowers with perfect, regular, tubular corollas; the ligulate flowers, if present, without stamens.

* Mostly perennials.

Pappus of fragile, unequal bristles; heads with or without rays; plants pubescent	ERIGERON.
Coarse plants with large heads.	
Pappus none; leaves sagittate or pinnate; root thick.	BALSAMORHIZA.
Pappus a narrow crown; leaves acute at both ends.	WYETHIA.
Pappus a pair of opposite paleæ; leaves broad and notched or lanceolate and entire (one an annual).	HELIANTHUS.

Pappus none; heads many and small; leaves finely dissected .... ACHILLEA.

Pappus of copious soft bristles; leaves various; flowers bright yellow .... SENECIO.

* * Biennials.

Pappus of several short obtuse paleæ; leaves finely bipinnate .... CHÆNACTIS.

Pappus of long plumose bristles united in a ring at base; plant prickly .... CNICUS.

* * * Annuals.

Plants very small, wooly.

Pappus none in the fertile flowers; heads not radiate STYLOCLINE.

Pappus of 2 opposite paleæ; rays with yellow ligules .... EATONELLA.

Plants larger, branched, pappus of numerous soft capillary bristles; heads small; rays mostly white .... ERIGERON.

Ligules 3-cleft.

Pappus none; all the flowers white............. BLEPHARIPAPPUS.

Pappus of several hairy awns; rays white; disk yellow .... LAYIA.

Pappus none; flowers yellow, usually closed .... LAGOPHYLLA.

Pappus of 5 rigid awns; the inconspicuous rays yellow; plant slender .... RIGIOPAPPUS.

Pappus of 5 paleæ, or with 5 alternating shorter additional ones; flowers white .... CHÆNACTIS.

Pappus none; disk conical, yellow; rays white.......... ANTHEMIS.

Series II. LIGULIFLORÆ. Flowers all ligulate and perfect. Ours yellow.

* Perennials; pappus of copious white capillary bristles.

Heads terminating the branches; akenes not beaked.... CREPIS.

Heads terminating simple scapes.

Akenes beaked and striate...................... TROXIMON.

Akenes beaked and toothed at apex .... TARAXACUM.

* * Annuals; pappus various.

Heads scapose.

Pappus partly plumose........................ ANISOCOMA.

Pappus of 5 paelæ, each awned at the apex....... MICROSERIS.

Pappus soft, capillary; akene prominently beaked .. TROXIMON.

Heads peduncled.

Pappus soft, capillary, partly deciduous, partly persistent .... MALACOTHRIX.

Pappus soft, capillary, persistent; akenes flattened.. SONCHUS.

ERIGERON. Disk flowers yellow. Rays ligulate or tubular, variously colored. Involucral bracts narrow, erect. Style appendages short, obtuse. Pappus of fragile, capillary bristles. Akenes pubescent, commonly 2-nerved and flattened.

* Perennials; pappus of several slender bristles with numerons shorter ones at the base.

E. concinnus, Torr. and Gray. Spreading from a usually simple root, 6 in.–1 ft. or more high: hirsute-pubescent with long spreading hairs: lower leaves spatulate, becoming oblanceolate or lanceolate, 1–2 in. long: heads slender peduncled, scattered, ½ in. or less broad; the blue or purple (rarely white) rays numerous in two series, very narrow, 2–3 lines long; involucral bracts numerous in about 3 series, narrow, nearly equal, 2 lines long.—Common, usually in the vicinity of moist places. May–Sept.

Var. **aphanactis,** Gray. Very similar to the last, recognized by the more or less closely corymbed clusters of flowers, which are conspicuously yellow by the absence of ligulate rays: stems usually from a short, branched, woody base, clustered, 4–8 or 12 in. high: leaves usually slenderer, often 3 in. or more long below: ray corollas short-tubular, the limb oblique; the shorter pappus often squamellate.—Commonest on dry hillsides among rocks and sage-brush. May–July.

* * Annual or biennial; pappus of numerous, nearly equal bristles.

E. Canadensis, Linn. Erect, slender, 1–4 ft. high, usually sparcely ciliate-hispid: leaves simple or sometimes slightly toothed, oblanceolate below to linear-lanceolate above, 1–3 in. long, ciliate margined: heads very numerous, panicled, but 2 lines high; involucral bracts in 2 or 3 unequal series; rays inconspicuous, white or pinkish, narrow, scarcely exceeding the pappus.—A common plant frequenting moist places.

STYLOCLINE. Low, floccose-woolly. Leaves entire. Heads small, glomerate-clustered. Annual.

S. filaginea, Gray. Densely matted, 1–3 in. high, appressed-lanate: leaves ½ in. or less long, linear to spatulate: heads 1–2 lines high; involucre of 5–12 fructiferous hyaline-tipped bracts arranged about the slender receptacle; these bracts enclosing the fertile pistillate ray flowers having. slender tubular corolla; the 4 or 5 perfect flowers sterile, subtended by bracts at the apex of the receptacle; pappus none, at least in the perfect flowers; anthers distinctly caudate.—On hard open ground in May.

BALSAMORHIZA. Coarse perennial herbs with radical leaves and stout root with thick bark. Heads yellow, showy, on scape-like stems. Akenes glabrous without pappus, 4-angled in the disk, each with a lanceolate bract. Involucre broad, the outer bracts foliaceous. Style appendages slender-subulate.

B. sagittata, Nutt. In tufts, spreading, from one to two and a half feet high: silvery-canescent, especially the under sides of the leaves, white woolly about the heads and at bases of stems and petioles: leaves chiefly a radical cluster, long slender petioled, cordate-oblong to hastate, entire, the blade 4–6 in. long: stems very slender, little exceeding the leaves, bearing a few lanceolate leaves and from 1–3 flowers: rays 10–15, 1–1½ in. long with short tube.—Scattered over the foothills and in patches in open places. May, June.

B. Hookeri, Nutt. Lower, with root similar to the last: canescent or finely appressed pubescent, woolly at base: leaves lanceolate, 6–15 in long, pinnately parted or divided, the segments mostly lanceolate, entire to irregularly pinnately parted: scapes slender, 6–18 in. high, usually leafy at base; heads solitary, broad, canescent to lanate, the lanceolate acuminate involucral bracts often nearly equal; ligules 15-20, ¾–1¼ in. long.—Commonest in rocky places, chiefly upon the foothills. May, June.

WYETHIA. Perennial, coarse, with stout root and yellow flowers. Bracts among the flowers. Akenes angled. Pappus a narrow chaffy crown with 2 (more in the rays) subulate awns. Style appendages filiform.

W. mollis, Gray. Tufted, 1–2 ft. or more high: white woolly when young, more or less glabrate with age: leaves mostly radical, petioled, mostly acutely elliptical with prominent midrib and pinnate venation, often a foot or more long by 4 in. or more broad: stems about equaling the leaves, with few alternate leaves, often branching: heads commonly 2, subtended by a single leaf, short peduncled, densely woolly, the few involucral bracts broad, ligules an in. or more long, 10–15.—On the foothills. May and June.

HELIANTHUS. SUNFLOWER. Having the characteristic large yellow heads. Akenes angled. Pappus of two opposite paleæ, promptly deciduous.

* Annual.

H. annuus, Linn. COMMON SUNFLOWER. Annual, erect, branching with age, 2–6 ft. high, often robust: hispid or scabrous, stems often mottled: leaves petioled, ovate in outline, irregularly serrate to deeply notched, from 2 to 6 in. or more long; heads almost sessile, hirsute, the broad imbricated involucral bracts abruptly acuminate: ligules numerous, over an in. long.—The common sunflower of the hills. In flower during Summer, the smaller foothill plants disappearing early.

* * Perennial.

H. Californicus, Nuttall., Torr and Gray. Perennial, often tufted, from a branched caudex: stems, few or several, 1–2 ft. high: scabrous, especially the leaves, the stems nearly smooth below: leaves lanceolate with narrowed base, 3–6 in. long, the larger 3-nerved near the base: heads solitary on simple or leafy peduncles, ¾–1 in. broad, the involucral bracts lanceolate to subulate, acuminate: bracts of receptacle acute: rays 12–20, the ligules an in. or more long, broad.—Common in moist places on the hillsides. May and June.

BLEPHARIPAPPUS. Flowers all white. Fertile rays 3–6, conspicuous, 3-cleft. Pappus short, of many apparently plumose bristles. Involucral bracts narrow, nearly equal.

B. scaber, Hook. Annual, 6–18 in. high, slender, loosely branching: puberulent and scabrous, glandular and usually somewhat hirsute in the inflorescence: leaves linear, an in. and less long: heads short peduncled, numerous, terminating the branchlets, ¼ in. high, about equaling the spreading rays; corolla of disk flowers expanded; anthers purplish: mature akenes black, densely silky-villous.—Common among the sage-brush, May and June.

LAGOPHYLLA. Heads in close leafy clusters, opening chiefly in the morning. Akenes without pappus. Stems mostly becoming naked below with age.

L. ramosissima, Nutt. Annual, becoming paniculately much branched, finely and softly pubescent: leaves oblanceolate-spatulate below, bract-like and densely ciliate margined above, the former falling early: heads 3 lines high, the 6 or 8 involucral bracts enclosing the fertile rays, the 4–6 central tubular flowers sterile; ligules pale yellow, 1–2 lines long, 3-cleft: akenes smooth, black.—Dry ground. June–Oct.

LAYIA. Disk flowers numerous, rays several, the ligule broad, 3-lobed or -cleft, white. Pappus in the disk only, of 9–12 slender awns having long hairs at base. Involucral bracts slender, about equal, some embracing the ray akenes.

L. glandulosa, Hook. and Arn. Annual, often stout, 6–12 in. high: hirsute, dark glandular above: leaves oblanceolate at base, becoming broadly- to linear-lanceolate above, entire or few toothed: heads short-peduncled, ½–¾ in. broad, the yellow centres and white rays conspicuous: aken essilky-villous.—Very common among the sage-brush. May, June.

EATONELLA. Flowers small with 8–10 light yellow rays, the involucre of as many narrow equal bracts. Pappus of 2 toothed paleæ, the middle tooth acuminate. Akenes silky-villous at the angles.

E. nivea, Gray. A depressed annual an in. or so high, densely woolly, the stems, leaves and flowers much crowded: leaves spatulate, a half in. or less long: heads sessile, 3–4 lines high; ligules a line long, notched: mature akenes shining black, white villous-margined.—In sandy places in May and June.

RIGIOPAPPUS. Very slender, involucral bracts slender, mostly in one or two rows. Rays 5–15; ligules not exceeding the pappus, inconspscuous, light yellow. Pappus of 3–5 rigid, subulate awns. Akenes slender.

R. leptocladus, Gray. Annual, 4–12 in. high, minutely hirsute-pubescent, except the upper branches, which are leafless below: leaves narrowly linear, an in.

or less long: heads terminating the branches, 3–4 lines high when young, becoming larger with age; pappus conspicuous beyond the involucre; the linear akenes equaling the involucre, finely pubescent and minutely alveolate.—On hard ground among sage-brush. May, June.

CHÆNACTIS. Spring plants, with flowers all tubular and exserted, white or cream-colored. Pappus of hyaline paleæ varying with the species. Leaves pinnate.

C. Douglasii, Hook. and Arn. A more or less stout and strict biennial, 1–2 ft. high, branching chiefly below; tomentose or glabrate, minutely glandular in the inflorescence: leaves petiolate, lanceolate, 2–3 in. long, divided into many narrow pinnate segments: heads paniculately corymbed, 6–9 lines high; involucral bracts rather obtuse; marginal corollas not larger than the others; pappus of about 10 narrow obtuse nearly equal paleæ.—Among sage-brush and on hillsides. May–July.

C. Xantiana, Gray. Annual, rather stout, branching, 6–12 in. high: glabrous or minutely tomentose in the inflorescence: leaves with few slender segments, or entire and linear above: heads scattered, the short peduncles usually thickened at apex; involucral bracts mostly acute; no distinctly enlarged marginal flowers; pappus of 5 lanceolate paleæ, alternated by 5 shorter obtuse ones.—Common, usually on light soils. May, June.

C. stevoides, Hook. and Arn. A slender, usually much branched annual, 4–8 in high: minutely woolly, especially above, or glabrous: leaves with few or several segments, these entire or few-lobed or -cleft: heads scattered, short slender peduncled, ½ in. or more high, the involucral bracts mostly obtuse: a few marginal flowers with distinctly enlarged corollas: pappus of 5 lanceolate paleæ.—Generally distributed on wild land, but less common than our other species. May, June.

ANTHEMIS. Heads many flowered. Akenes destitute of pappus, rough.

A. cotula, L. MAY-WEED. Annual, strong scented, a foot or more high with spreading branches: sparingly finely pubescent or smooth: leaves sessile, an in. or two long, 2-3-pinnately divided into fine linear segments: heads scattered, slender peduncled, ¼ in. or more high, the conical yellow disk conspicuous, the dozen or more white rays 3–4 lines long.—An introduced Eastern wayside weed; flowering during Summer.

ACHILLEA. Heads small, densely clustered. Bracts of the receptacle and inner involucre membranaceous. Akenes glabrous, destitute of pappus.

A. millefolium, L. MILFOIL. Perennial, erect, 1–2 ft. high, villous or sometimes glabrate: leaves narrowly lanceolate, 2–4 in. long, the radical often 6–10 in. long, very finely and numerously bipinnately divided: heads 2 lines high, numerous in a crymbose panicle crowning the stem; ligules white or rose-colored, few, a line broad, mostly 3-lobed; disk flowers cream-colored.—Common in meadows and similar places. Frequent in the wild state in the Sierra Nevada Mts. June–Sept.

SENECIO. A large genus having slender equal involucral bracts and soft capillary pappus. Akenes longitudinally ribbed.

S. aureus, L. From a slender rootstock, a foot or two high, simple or branched from the base: light green, smooth or nearly so with some scattered tomentum:

leaves exceedingly various, the radical usually rounded or oblong. entire or crenate-dentate, slender petioled, the cauline pinnately cleft or parted, with acutely lobed segments: heads several, loosely cymose, slender peduncled: flowers all bright yellow, the dozen or more rays 3–5 lines long. An apparent variation is more tufted; the leaves very much pinnately cut, the ultimate segments acute; the lower scarcely lyrate: heads more closely clustered.—On moist wild land. June, July.

CNICUS. Thistle. Biennial, coarse with prickly leaves and bracts. Heads usually large. Flowers all tubular. Corollas linear, deeply and narrowly cleft. Pappus of plumose bristles united at base to form a dehiscent ring.

C. Andersonii, Gray. Stout, 2–5 ft. high, densely white woolly, leaves 4–6 or 8 in. long, coarsely and often sinuately pinnatifid: heads an in. or two high and broad, mostly bracteate-peduncled; flowers red; involucral bracts in 5 or 6 unequal series, slender, tapering, mostly straight, all except the inner spinous tipped, the outer often reflexed; corolla about 1¼ in. long, the lobes not exceeding the tube.—The common bright flowered thistle of our range. June–Sept.

ANISOCOMA. Leaves radical. Heads cylindrical on simple scapes. Flowers ligulate. Pappus partly simple, partly plumose.

A. acaule, Torr. and Gray. Annual, 3–6 in. high; glabrous excepting patches of white tomentum on the leaves: these rosulate, 2–3 in. long, scarcely runcinately lobed or cleft with fine dentation: scapes slender: involucre of imbricated, unequal, obtuse, scarious margined bracts having colored midvien; flowers yellow or cream-colored, opening in morning and on dull days.—Found in sandy places in May.

MICROSERIS. Leaves radical. Heads scapose. Flowers all ligulate. Pappus of 5 paleæ with a delicate awn extending from the notched apex of each. Akenes attenuate upward.

M. linearifolia, Gray. Annual, 6–12 in. high, smooth or finely pubescent when young: leaves narrow, acuminate, entire or mostly openly pinnately toothed to pinnatifid: scapes few to several, rather stout, enlarged toward the top: heads an in. or less high, the involucral bracts lanceolate in two series, the outer shorter: flowers light yellow, inconspicuous, pappus pure white; akenes slender, minutely barbed, about ½ in. long.—In loose soil, often in rocky places. Plants on shaded rich land are often much taller. May, June.

MALACOTHRIX. Flowers ligulate, yellow. Involucral bracts narrow, mostly equal in one series with shorter ones at base. Pappus soft, white, capillary, a part united at base and falling, leaving 5 persistent bristles. Akenes unequally and longitudinally ribbed.

M. Torreyi, Gray. Eerect with spreading branches; leafy throughout: mostly smooth, sometimes glandular pubescent on the peduncles and involucre: leaves 2 or 3 in. long, sinuately and acutely pinnatifid or pinnately parted, the segments more or less toothed: heads scattered, drooping in the bud, less than ½ in. broad: flowers bright yellow.—On open dry ground. May–July.

M. glabrata, Gray. Mostly very slender, sometimes in dense tufts and rather succulent; 6–18 in high, almost wholly smooth throughout: leaves in a radical cluster, 2–4 in. long, very slender, pinnately divided into few almost filiform segments: stems branching from the axils of very small insignificant leaves (mostly scapose in small young plants): heads scattered, usually fully ½ in. broad: corollas light yellow, rather showy.—Commonest on light soil, often among sage-brush. May–July.

CREPIS. Ours perennials with yellow ligulate flowers. Involucral bracts narrow, mostly equal in a single series with some shorter ones at base. Akenes smooth, tapering above, 10-ribbed, usually brown at maturity. Pappus of copious white soft bristles, persistent.

C. occidentalis, Nutt. Rather robust, 6–15 in. high; canescently tomentulose: leafy throughout; radical leaves petiolate, broadly lanceolate, acute, pinnatifid with coarse dentate segments: heads corymbed, the involucre ½ in. high, broad: flowers 12–20, mostly light yellow: akenes prominently ribbed.—Very common generally. May–July.

Var. **Nevadensis,** Kell. Slenderer, more or less tomentose, especially upon the heads, somewhat hirsute below; leaves slenderer, narrowly and sinuately parted; akenes less prominently ribbed.—Found on the higher hills.

C. acuminata, Nutt. Slender, 2–3 ft. high, the stems often weak: tomentulose or even glabrous in the often light green inflorescence: leaves bract-like at apex, the radical long petiolate, lanceolate, often a foot long, deeply pinnatifid or parted into acuminate segments, the apex entire, long slender pointed: heads numerous in a loose corymbose cyme, smaller than in the preceding, but 2 or 3 lines broad, 6–10 flowered, often deep yellow: akenes evidently longer than the pappus.—Common in the hills, frequently in shaded places. May–July.

TROXIMON. Dandelion-like. Leaves all radical, various. Heads many flowered, terminating simple scapes. Akenes fusiform, striate, grayish with a slender beak. Pappus soft, white.

* Annual.

T. heterophyllum, Greene. 6 in. to a foot high; sparingly villous-pubescent or even tomentose in the young growth, often partially glabrous: leaves 2–6 in. long, pinnately toothed to parted into narrow distant segments, obtuse to acuminate at apex: scapes very slender: heads ¾–1 in. high; involucral bracts lanceolate, in 2 or 3 unequal series: akenes nearly 2 lines long.—Common along roadsides. June, July.

* * Perennial.

T. grandiflorum, Gray. Robust, from a stout root, 1–2 ft. high: sparingly villous or even tomentose below, particularly so in the heads, otherwise glabrous or nearly so: leaves from a few inches to a foot or more long, oblanceolate, obtuse, from entire to pinnatifid: scapes stout, often striate; heads 1–1½ in. high, broad; involucral bracts in 3 to several series, imbricated: akenes 3 lines long, the beak nearly ¾ in. long; ripened heads larger and more showy than those of the dandelion.—Common in the hills west of Reno. June, July.

TARAXACUM. Leaves radical. Heads scapose. Akenes beaked. Perennial.

T. officinale, Weber. DANDELION. Plant mostly nearly smooth; leaves from nearly entire to runcinately pinnately cleft or parted, or even lyrate: scapes hollow, smooth or somewhat woolly: outer involucral scales reflexed in mature heads: akenes toothed at apex, the beak slender.—Common in yards, shaded plants becoming a foot or more high. Throughout Summer.

SONCHUS. SOW THISTLE. Rather coarse, erect, annual weeds, 2–3 ft. high with thin runcinately and lyrately pinnatifid or deeper cut thin leaves, 3 to several in. long and soft spinulose margined, the upper clasping at base. Stems mostly smooth below, glandular above. Heads half an in. or less high, loosely cymosely arranged, involucral bracts narrow. Flowers yellow, inconspicuous. Akenes thin, 1½ lines long. Pappus soft, white, falling early. Flowering throughout Summer.

S. oleracea, L. Bases of the stem leaves acutely pointed: akenes striate-nerved, scabrous.—Less common than the following.

S. asper, Vill. Bases of the stem leaves rounded: akenes 3-nerved, thin and often scabrous margined, otherwise smooth.—Very common on cultivated lands.

LOBELIACEÆ.

LOBELIA FAMILY.

Herbs with perfect 5-merous flowers and alternate simple leaves. Calyx adnate to the 1- or 2-celled ovary. Corolla more or less bilabiately irregular, epigynous. Stamens alternate with the corolla lobes. Style simple. Capsule many seeded.

NEMACLADUS. Low diffuse annuals. Filaments united. Stigma capitate. Capsule 2-celled, the placentæ in the axis. Pedicels filamentous. Branches zigzag.

N. ramosissimus, Nutt. Delicate, 2 or 3 in. high, much branched; smooth or sparingly puberulent below: leaves a radical cluster ¼–¾ in. long, oblanceolate or spatulate, bract-like on the branches: flowers 2 lines long, broad, rounded at base, on pedicels 3–4 lines long; lateral calyx lobes the larger: corolla shorter than the calyx lobes, flesh colored; capsule globular, not exceeding the calyx.—In sandy places, Peavine Hills. May, June.

ASCLEPIADACEÆ.

MILKWEED FAMILY.

Herbs, with milky juice. Leaves entire without stipules. Flowers regular, the parts in fives except the ovaries of two distinct carpels having a common stigma. Pollen in a solid waxy mass. Fruit a pair of follicles. Seeds with a silky coma.

ASCLEPIAS. Calyx and corolla each deeply 5-parted, the segments reflexed. Filaments in a tube, a conspicuous hood behind each anther. The anthers united to the broad stigma. Pollen in 10 pear-shaped masses united in pairs. Styles short, distinct. Seeds flat, numerous on a common placenta. Perennials.

A. cryptoceras, Watson. Low; stems few, decumbent, 6–12 in. long: plant glabrous throughout, glaucous: leaves in 3 or 4 opposite pairs, broadly ovate or orbicular, 1 or 2 in. long, very short petioled: flowers in umbels, greenish-white; pedicels an in. or more long; sepals narrow; petals larger, oblong, ½ in. long; hoods purplish, cleft at apex, 2 or 3 lines long: follicles broadly lanceolate, 1½–2 in. long.—On light soil in the foothills. May–Aug.

POLEMONIACEÆ.

PHLOX FAMILY.

Ours herbs, with regular flowers in which the parts are five each, except the pistil, which has a 3-celled ovary and a slender 3-branched style. Calyx imbricated in the bud, the corolla convolute. Stamens on the corolla alternate with its lobes. Capsule 3-valved. Seeds few.

Leaves opposite, or alternate only above; stamens unequally inserted in the upper part of the tube .... PHLOX.

Leaves alternate, or the lower opposite; stamens as in the preceding, but often exserted ....COLLOMIA.

Leaves opposite or alternate; stamens equally inserted in the throat of the corolla .... GILIA.

PHLOX. Calyx narrow, 5-cleft. Corolla salver-form, the orifice narrow. Stamens included, unequally inserted on the upper part of the tube. Leaves entire, opposte. Inflorescence cymose.

P. longifolia, Nutt. Stems one to several from a woody base, slender, 6–12 in. high, more or less smooth, shining below: mostly glabrous below, pubescent and glandular above: leaves slender-lanceolate to linear, 1 to 2 in. long: flowers white or pale blue, expanding ¾ in., the tube as long; calyx slender, deeply cleft: capsule oblong, 2 to 3 lines long, "cells 1-seeded."—Under shrubs and in protected places. May–July.

Var. **brevifolia,** Gray. 4–6 in. high from a woody branched base: pubescent, the inflorescence glandular, or some leaves smooth: leaves broadly to narrowly lanceolate, an inch or less long; flowers pedicelled; calyx about ½ in. long, its lobes slender; corolla tube a half longer, its lobes broad, 3–5 lines long, the corolla whitish, purple tinged or rose-colored: capsule 2 or 3 lines long. —Very generally distributed on hillsides and along roadsides. Apr.–June.

COLLOMIA. Calyx 5-cleft, often obconic. Throat of corolla commonly enlarged. Stamens more or less exserted, unequally inserted in or below the throat of the corolla. Ours annuals.

* Calyx obconic.

C. grandiflora, Dougl. Erect, slender, 1–3 ft. high: very minutely pubescent or smooth in age, glandular in the inflorescence: sparingly branched; leaves alternate, simple, lanceolate, 1 or 2 in. long: flowers showy, capitate-clustered at the summit and in the upper axils, the upper cluster with broad leafy bracts about the base: calyx obconic, the acute lobes green tipped; corolla an in. long, the tube narrow, throat ample, lobes obtuse, 2 or 4 lines long, yellowish or creamy-white.—In shaded places. June, July.

C. linearis, Nutt., var. **subulata,** Gray. Diffusely branched, a ft. or less high: viscidly glandular pubescent, with some villous hairs: leaves alternate, linear below, linear-lanceolate above, 1–1½ in. long: flowers few in the axils, short pedicelled; calyx obconic, about 3 lines long, deeply cleft into slender pointed greenish segments; corolla brownish-purple, 4 or 5 lines long, the tube very narrow, the lobes a line or less long: capsule 2 lines long. —In sandy places along the base of the Sierra Nevadas. May–July.

* * Calyx cylindrical.

C. gracilis, Dougl. Low (2–6 in. high), at first simple, becoming diffusely branched with age; from finely pubescent, often glandular throughout, to almost smooth: lower leaves often purple beneath: leaves sessile, opposite, oblong-lanceolate, ½–1 in. long below, to alternate, subulate, and shorter above: flowers scattered (in older plants), ¼ in. or more long, narrow: corolla somewhat exceeding the caylx, rose-colored, usually with a deeper eye in the lobes, turning blue with age; stamens included: capsule shorter than the slender scarious margined calyx segments.—The commonest of Spring plants, blooming from April till mid-Summer.

C. leptalea, Gray. A very slender annual, 6–8 in. high, loosely paniculately branched: viscid glandular puberulent or smooth: leaves filiform linear, bract-like above: flowers scattered; pedicels filiform; calyx minute (a line long) with subulate teeth; corolla 4 or 5 lines long, tubular at base, funnelform above the middle, the tube yellow, the lobes blue: capsule a line or more long. —Along the Truckee river in the Sierra Nevadas. Reported from Glendale. In Summer.

GILIA. Calyx 5-cleft, not obconic. Throat of corolla expanded or contracted. Stamens often unequal, but equally inserted.

* Annuals.

G. inconspicua, Dougl. Much branched from the base, 4–12 in. high: more or less glandular, often densely so; the leaves more or less woolly; these pinnatifid, the pointed segments simple or toothed, the lower 1 or 2 in. long, becoming bract-like above: flowers 3–5 lines long, numerous, scattered; calyx a line or two long; corolla tube slender, exserted, mostly purple and yellow; limb spreading, lobes a line long, blue; filaments little exceeding the anthers: capsule 2½–3 lines long, broad, equaling the enlarged calyx.—The commonest of our species, variable, flowers often white. April–July.

Var. **sinuata**, Gray. Very similar to the preceding in habit, the flowers conspicuously larger; corolla funnelform above the middle, lobes 2 lines long; filaments slender, nearly equaling the corolla lobes.—Within restricted areas on the foothills. May–July.

G. leptomeria, Gray. Diffusely much branched, 6–10 in. high; the ultimate branchlets very slender: minutely viscid-glandular: leaves chiefly a radical cluster, 1–2 in. long, lanceolate, pinnatifid, the lobes often setaceously tipped; the cauline mostly entire, narrow, chiefly bract-like: flowers very numerous, scattered; calyx little exceeding a line long; corolla 2 lines long, the narrow tube yellowish-white, the limb bluish-purple, the lobes usually toothed: capsule 1½–2 lines long: ovules several.—In the Truckee pass, Virginia Mts. May–June.

G. floccosa, Gray. Slender or branched in age; 6–12 in. high, flocose-woolly, at least when young, glabrate: leaves rather rigid, narrow, with 1–3 pairs of linear lateral segments, or simple, pungent: flowers crowded in small, scattered, woolly capitate clusters; the 3-parted floral bracts exceeding the narrow calyx, whose pungent tipped segments are more or less unequal; corolla tubular with ample throat, 5 lines long, light blue, with lighter base, occasionally white: capsule 2–3 lines long, few seeded.—Very common on open ground. June–Sept.

G. nudicaulis, Gray. A most delicate little plant but 2–4 in. high: glabrous throughout: stem usually simple, or branching at the base, and occasionally in the first leaf cluster in the larger specimens: leaves several, ½–¾ in. long, ovate-lanceolate or narrower, in a rosulate involucre-like cluster subtending a crowded cluster of sessile showy flowers: these white, yellow, or more frequently rose-pink or light blue; calyx ample, narrowed at throat; corolla tube linear, ½ in. long, the limb rotate, lobes 3 lines long, broad and often toothed at apex; anthers sessile in the throat: capsule 2 lines or more long. —In light soil among sage-brush. Late April and May.

* * Biennial.

G. aggregata, Spreng. From a woody root: stems one or few, rather stout, more or less pubescent: leaves pinnately divided into linear mucronulate segments, clustered at base: flowers showy in a slender loose panicle; calyx 2–4 lines long (variable), the segments acuminate; corolla tubular-funnelform, ½–1¼ in. long, bright crimson or pink, the recurved lobes acute; stamens inserted on or below the throat, mostly exserted: capsules 3–4 lines long.—Along the Truckee river, chiefly in the hills. June–Sept.

HYDROPHYLLACEÆ.

WATERLEAF FAMILY.

Ours herbs with mostly scorpioid inflorescence. Flowers regular, 5-merous. Stamens upon the base of the corolla, alternate with its lobes. Ovary nearly or quite 2-celled. Seeds few or several. In ours the calyx divided nearly to the base; style 2-cleft.

Inflorescence scorpioid; flowers not yellow, excepting partially so in one species	PHACELIA.
Inflorescence as in Phacelia; flowers wholly yellow	EMMENANTHE.
Flowers solitary axillary, not yellow; stamens unequally inserted	CONANTHUS.

PHACELIA. Inflorescence scorpioid. Stamens equal, often exserted and bearded. Corolla partially yellow in one species.

* Ovules only 4, 2 in each cell of the ovary.

P. circinata, Jacq. f. Erect, 1–2 ft. high from a biennial root, often stout: finely pubescent with additional stiff, mostly appressed hairs; plants generally with a grayish aspect: leaves mostly lanceolate, petiolate, the lower often with some lateral divisions or leaflets; spikes crowded, forked, densely flowered; corolla white, early becoming brown, ¼ in. or less long, the stamens prominently exserted and distinctly bearded.—Common on the hills. May–July.

P. humulis, Torr. and Gray. Erect, branching, annual, 6–12 in. high: finely pubescent, somewhat hirsute below, more prominently so above: leaves broadly lanceolate, 2–3 in. long: flower clusters closely crowded, erect; flowers violet, 3 or 4 lines long; calyx segments linear, style and stamens exserted; racemes somewhat elongated with age.—In open places on the hills. May–July.

P. ramosissima, Dougl. Perennial, 2 ft. high, straggling, branches several from the base; hispidulous or merely puberulent, especially the leaves, hirsute and glandular in the inflorescence, the hirsute hairs long and dense in the flower clusters: leaves 2–3 in. long, pinnately parted or divided into oblong entire to pinnatifid segments: spikes dense, rounded; flowers 3 lines long, yellowish-white; style and stamens somewhat exserted; calyx segments narrow, often unequal, exceeding the capsule.—Along the banks of the Truckee river, June, July.

* * Ovules several (6–12) in each cell of the ovary.

P. Menziesii, Torr. Annual, slender, 4–8 in. high; minutely pubescent, hirsute in the inflorescence: leaves linear or lanceolate, entire or with few narrow segments: spikes short, few flowered, closely clustered: flowers rather showy, violet with more or less white, 3 or 4 lines long; style and stamens somewhat exserted.—In the hills, common about Verdi. May, June.

P. curvipes, Torr. Annual, stems weak, spreading, 6–10 in. long; minutely pubescent and hirsute; leaves entire, lanceolate or oblanceolate, petiolate, 1–2 in. long: flowers deep blue, 3 lines long; stamens included or slightly exserted; raceme becoming open with age; calyx becoming 4 or 5 lines long, pedicelled in age.—In the shade of rocks on the hills. May, June.

P. bicolor, Torr. Annual, with spreading, rather weak stems from the base, but a few inches high: minutely hirsute-pubescent, somewhat glandular: leaves 2–4 in. long, bi-pinnately parted into narrow obtuse segments: racemes several flowered: corolla funnelform, 5–7 lines long, with yellow tube and violet limb; the narrowly segmented calyx ⅓–½ as long; style branched at the apex, this with the stamens included.—Not uncommon in sandy places. Apr.–June.

EMMENANTHE. Similar to Phacelia, but differing in the wholly yellow persistent corolla.

E. lutea, Gray. Annual, decumbent, spreading: minutely pubescent: leaves 1–2 in. long, serrately pinnatifid into several rounded segments; spikes short, elongating with age: flowers nearly ¼ in. long, the campanulate corolla exceeding the linear spatulate calyx divisions.—On hard open ground. Apr.–June.

CONANTHUS. Calyx segments narrowly linear. Corolla falling early. Flowers solitary in the axils of the branches. Stamens unequal.

C. aretioides, Watson. Annual; finely rough hirsute; often flowering at an in. or more high; branches forking repeatedly, the plant often forming a mat a foot or more broad with age: leaves linear-lanceolate, an in. or more long: flowers sessile, funnelform; corolla pink to purple, ½–¾ in. long, narrow at base, the limb expanded.—In sandy places. May–July.

BORRAGINACEÆ.

BORAGE FAMILY.

Herbs, ours mostly hispid-hairy. Leaves mostly alternate, entire. Inflorescence racemed or scorpioid. Flowers regular, 5-merous. Stamens on the corolla, as many as its lobes and alternate with them. Ovary 4-parted. Style and stigma simple, except in the first. Fruit of 4, or sometimes fewer, 1-seeded nutlets.

* Style 2-parted; stems not hispid.

Branches prostrate; leaves petioled; flowers clustered in the axils .... Coldenia.

* * Style simple; plants hispid throughout.

+ Nutlets spreading.

Flowers scattered on the branches, white; nutlets thin, margined .... Pectocarya.

+ + Nutlets erect about the style.

Flowers as in Pectocarya; nutlets armed with barbed prickles .... Echinospermum.

Flowers mostly small, white, scorpioid; nutlets more or less rough, or smooth .... Krinitzkia.

Flowers larger, yellow, scorpioid; nutlets rough, somewhat flattened .... Amsinckia.

COLDENIA. Style 2-cleft or 2-parted. Ovary deeply 4-lobed. Flowers sessile in clusters in the forks of the branches.

C. Nuttallii, Hook. Annual, prostrate, repeatedly dichotomously branched, spreading with age: canescently appressed-pubescent: leaves 2 or 3 lines long on equal slender petioles, elliptical, prominently grooved above at the venation: flowers 2 lines long; calyx segments slender, sparingly hispid; corolla pinkish, little exceeding the calyx, with 5 scales at base, bearing the short stamens in the throat: fruit of 4 shining, smooth nutlets less than a line long.—In light soil throughout Summer.

PECTOCARYA. Slender diffuse annuals with narrow linear leaves. Flowers small, scattered along the whole length of the branches. Nutlets winged.

P. penicillata, A. DC. From 6 to 10. in. high, branching from the main stem; branches often somewhat zigzag; appressed-hirsute, the leaves and calyx hispid: leaves ½–¾ in. long: corolla white, minute, exceeding the narrow calyx segments, which elongate in fruiting: nutlets conspicuously divergent, thin, 1½ lines long, including the horseshoe-shaped wing, beset with hooked bristles, often not all maturing.—On wild land. June–Aug.

ECHINOSPERMUM. STICKSEED. Ours annuals. Flowers scattered along the branches, but a line long, white or bluish, pedicelled. Leaves linear or oblanceolate, the lowermost spatulate. Pubescence canescently appressed-hirsute. Nutlets armed with a row of doubly barbed bristles, more or less exposed.

E. Redowskii, Lehm. Erect, simple or branched above, 1–2 ft. high; leafy, the flowers bracteate; leaves ½–1 in. long: nutlets ovate; 1½ lines long, minutely rough, the prickles from a mere ridge upon the nutlet.—Sparingly found about Reno. June, July.

Var. **cupulatum,** Gray. Specimens found are not so tall, more diffuse: nutlets nearly smooth, the prickles from a rather broad membrane which forms a sort of cup upon the nutlet.—Taken at the English mill site in May.

KRINITZKIA. Mostly annuals, rough hispid and hirsute. Flowers mostly very small, scorpioid, in close or elongated clusters; the pubescence of the inflorescence becoming reddish-brown with age. Nutlets enclosed by the fruiting calyx. The commonest of our several species are:

K. leiocarpum, Watson. Mostly slender, branching loosely, a ft. or less high: not strongly hispid, hirsute, densely so in the flowers: peduncles slender, branching to form 2 or 3 spikes, which are mostly globular clustered when in flower, elongating with age; flowers minute: fruiting calyx 1–2 lines long, narrow: nutlets smooth, shining.—Common in rocky and protected places during Summer.

K. pterocarya, Gray. Very similar to the last, though often more densely branched, the leaves larger: fruiting spikes longer, more densely flowered; fruiting calyx longer, more ample, less densely hirsute, but some hispid bristles present: nutlets (usually but 3 of the 4) winged, the margin of the wing entire or somewhat jagged toward the apex; body of all the nutlets rough.—Associated with the last.

K. Kingii, (?) Watson. Stouter, with stouter, more enduring root; branching profusely from the base, from 4–18 in. high; densely hirsute and hispid, very leafy: leaves oblanceolate and 2–4 in. long below: flowers clustered; the white corolla exserted, the expanded limb 2–3 lines broad: fruiting calyx 2 lines broad, its narrow lobes spreading: nutlets minutely granulate and transversely ridged.—Common on the sandy hills west of Reno. Spring and Summer.

K. circumscissa, Gray. Annual, from an inch to 3 or 4 inches high, and much branched; appressed-hirsute, sparingly hispid: leaves linear, little exceeding ¼ in. long, crowded at the extremities of the branches: flowers in close clusters, surrounded and scarcely exceeded by the leaves; corolla white, minute; calyx but a line long, 5-cleft, circumscissile above the base: nutlets smooth. —Hard open ground. Apr.–Sept.

K. dichotoma, Greene. Very similar, but coarser, generally darker colored; pubescence more spreading: leaves ½–1 in. long, tending to become oblanceolate, exceeding the flower clusters; corolla limb expanding a line or more: calyx and nutlets as in the last.—Common, associated with the preceding.

AMSINCKIA. Prickly-hispid annuals with scorpioid inflorescence and yellow flowers. Larger bristles from an enlarged base.

A. intermedia, Fisch. and Meyer. Erect, 1–3 feet high, succulent when young, pubescence spreading, dense in the inflorescence: leaves oblanceolate below, narrowed at base, 3–6 in. long, lanceolate to ovate above, these 3-nerved at base: flowers mostly in pairs in the spike; calyx cylindrical, the sepals often partially connate; corolla 4–5 lines long, exceeding the calyx, the limb lobed, spreading; stamens within the tube, which is often brownish tinged at the throat; style slender: nutlets rugose-roughened, not exceeding half the length of the calyx: fruiting spike becoming 3–6 in. long.—Very common. Apr.–July. A. tessellata, which has flattened tessellated nutlets, probably occurs with this species.

SCROPHULARIACEÆ.

FIGWORT FAMILY.

Ours all herbs. Flowers perfect; the corolla irregular and bilabiate, or nearly regular. Stamens 2 or 4, or 5, one of them sterile. Style simple, stigma entire or 2-lobed.

Flowers small, blue and white; calyx and corolla nearly equal; stamens 4	COLLINSIA.
Flowers larger, mostly blue or purple; corolla much exceeding the calyx; stamens 5, one of them sterile; perennials	PENTSTEMON.
Flowers large or small; mostly yellow; stamens 4, in pairs; annuals	MIMULUS.
Flowers small, white; corolla nearly regular; stamens 2; annual, growing near water	VERONICA.
Flowers cylindrical; corolla pointed at apex; the conspicuous floral bracts yellow to crimson; anthers irregular	CASTILLEIA.

COLLINSIA. Winter annuals with leaves opposite below or whorled above. Flowers not rarely 2-colored. Lower lobe of the corolla keeled and including the four stamens. Filaments long and slender; anther cells confluent at apex.

C. parviflora, Dougl. 2–6 in. high, stems and under side of leaves more or less reddish-purple; puberulent or smooth: lowest leaves orbicular, short petioled; the upper oblong or lanceolate, narrowed at base: flowers about 3½ lines long: calyx bell-shaped, cleft, the segments pointed; corolla longer, lobes of the upper lip nearly white, the lower lip bluish: fruiting pedicels drooping, ½ in. or more long: capsule oblong, nearly equaling the calyx: seeds few.—In shaded and moist places. April–June.

PENTSTEMON. Perennials with opposite leaves. Flowers showy. Calyx 5-cleft. Corolla open, limb 2-lipped, the upper lip 2-lobed, the lower 3-cleft. Stamens 4, with confluent-celled anthers, a fifth stamen sterile with a conspicuous filament.

P. glaber, Pursh. Stout, glaucescent, light green, very smooth, 1–2 ft. high, often several stemmed from the base: lower leaves lanceolate or oblanceolate, attenuate-petioled, 3 or 4 in. long, the upper mostly lanceolate, sessile: flowers large, conspicuous in a close, raceme-like cluster; calyx segments broad, pointed, 4 lines long; corolla very deciduous, 1–1¼ in. long, broad, the limb bluish-purple, the tube lighter and narrowed at base: capsule ovate-acuminate, 6–8 lines long: pedicels short, stout.—On light soil among the foothills.

P. confertus, Dougl. Var. **cæruleo-purpureus,** Gray. Slender, a foot or more high; glabrous: leaves oblong-lanceolate, petiolate below: flowers in a few compact clusters about the common stem: pedicels very short; calyx a line or two long; corolla about 5 lines long, the limb blue, bearded within: capsule ovate, 2 lines long.—On the higher hills. In Summer.

P. Rœzli, Regel. Slender, 6 in. to a foot high; from a woody base; usually several stemmed; puberulent or glabrous below, more or less viscid-glandular above:

leaves narrow, oblanceolate, or mostly lanceolate: the inflorescence bracteolate, open, the branches spreading: flowers pedicelled, ¾ in. long; corolla violet-purple: capsule ovate 3–4 lines long.—Very common on the hills. May–July.

MIMULUS. MONKEY-FLOWER. Annuals. Calyx prismatic. Corolla bilabiate; ours mostly with expanded limb. Stamens 4. Style slender, the stigma somewhat expanded. Capsule contained within the persistent calyx.

M. nanus, Hook. and Arn. From one or two in. to several in. high; viscidly pubescent with a disagreeable odor: leaves ovate or oblong to lanceolate, sessile, an in. long: flowers conspicuously rose-purple; calyx 4–5 lines long, cleft into acute segments: corolla ¾ in. long, tube narrow and limb of sub-equal lobes, broad; corolla often somewhat mottled; stigma funnelform, hairy at base: capsule tapering, 4–5 lines long.—At Huffaker's and Steamboat Springs. May–Sept.

M. luteus, L. Erect, 1–2 ft. high, often stout; smooth or finely pubescent among the flowers: leaves oblong or ovate 2 in. or more long, the lower mostly petiolate, sinuately toothed to irregularly and rather coarsely notched: flowers yellow, conspicuous, mostly in a terminal cluster, pedicelled; calyx ample, strongly angled, bluntly toothed, 4–5 lines long: corolla nearly an inch long with broad open limb.—Very common in early Summer along streams and in moist places.

M. rubellus, Gray. Slender, simple, or much branched, 2–5 in. high; somewhat visidly puberulent: leaves oblong to linear-lanceolate, an in. or less long: owers pedicelled, calyx more or less reddish-purple, 3 lines long: corolla 4 or 5 lines long, not much expanded at throat, yellow.—Small plants found under sage-brush in Apr. and May.

Var. **latiflorus,** Watson. Diminutive plants but an inch or two high, with the conspicuous yellow flowers ½–¾ in. long with wide spreading limb which is more or less brown spotted, the tube very narrow.—Very common among sage-brush about Washoe lake. In Spring.

VERONICA. Leaves opposite. Corolla almost regular, 4-parted. Stamens 2.

V. peregrina, L. NECK-WEED. Annual, erect, 6–10 in. high, rooting at base; glabrous or glandular pubescent above: leaves ½–¾ in. long, oblong to lanceolate, dentate toward the apex, sessile: flowers axillary, sessile, 2 lines high; calyx deeply 4-parted: corolla white, its lobes rounded, one of them between the two stamens; capsule flattened, rounded-obcordate.—Very common in moist places everywhere. Spring till Autumn.

CASTILLEIA. PAINTED CUP. Both calyx and corolla tubular. Flowers proper inconspicuous. Calyx 2-cleft, the segments 2-lobed. Corolla 2-lipped, the upper forming the narrow tip, the lower 3-toothed, a mere slit forming the orifice. Stamens 4 in the upper lip.

C. parviflora, Bongard. Stems few or often numerous from a woody perennial base, 10–18 in. high; densely villous-pubescent or hirsute; stems often dark or purplish: leaves alternate, usually simple, linear-lanceolate below, becoming 3-cleft or 3-parted above, the segments simple or cleft; the floral bracts leafy, their yellow to crimson tips conspicuous: spikes compact, 2–6 in. long; flowers 6–9 lines long, the corolla exceeding the calyx, which is sometimes tinged with the color of the bracts; capsules broad at base, ½ in. long. Common among sage-brush and rocks in the hills. "Indian Pink." May–July.

NYCTAGINACEÆ.

FOUR-O'CLOCK FAMILY.

Our representative an herb. Perianth corolla-like, constricted over the free 1-celled, 1-ovuled ovary. Leaves opposite, entire petioled. Stamens few. Style and stigma simple.

ABRONIA. The involucre of scarious bracts containing numerous sessile flowers. Perianth slender tubular with rotate limb. Stamens and style included.

A. Crux-Maltæ, Kellogg. Annual, stems prostrate, about 3, pinkish, fleshy: smooth except the viscid branchlets and inflorescence: leaves unequal, 2–4 in. long, elliptical-oblong: peduncle 2 or 3 in. long; involucre of 6–8 acute distinct bracts: perianth rose-pink, tube expanded and greenish above, ¾ in. long; limb ½ in. or more broad, 4-parted, the segments 2-cleft; orifice square, stamens 4, unequally inserted; wings of fruit 2 or 3, orbicular, net-veined.—In sandy places. May–June.

POLYGONACEÆ.

BUCKWHEAT FAMILY.

Ours herbs with perfect flowers and alternate leaves. Stipules sheathing if present. Stamens various. Ovary 1-celled, triangular. Styles 3. Stigmas capitate.

* Perianth 5-parted: stamens 5.

Plant with leafy stems; flowers inconspicuous .... POLYGONUM.

* * Perianth 6-parted: stamens 9.

Flowers conspicuous, yellow, clustered .... ERIOGONUM.

Flowers inconspicuous, rose-colored, scattered; plant slender, open branched .... OXYTHECA.

Flowers inconspicuous, yellow; plant low, dense........... CHORIZANTHE.

POLYGONUM. Stems prostrate to erect in shade. Stipules prominent, sheathing, scarious. Sepals and stamens 5 each. Flowers inconspicuous, axillary, sessile, solitary or few.

P. aviculare, L. KNOT-GRASS. Annual, stems several, 4–12 in. long, glabrous, striate: leaves oblong-lanceolate, short petioled, an inch or less long: flowers greenish, the perianth segments white margined.—A common weed in yards. Throughout Summer.

ERIOGONUM. Including several species of our range. The following two perennial species with yellow flowers are commonest within our period.—Found among sagebrush. May, June.

E. umbellatum, Torr. 8–16 in. high from a much branched woody base, with short leafy stems: finely tomentose: leaves spatulate to lanceolate ½ in. or more long on slender petioles: peduncles from the base, slender: flowers in umbels of 3–7 rays an in. or more long each bearing a close cluster of many flowers; perianth narrow, short stemmed at base, 2–3 lines long: filaments villous: involucral bracts, leafy, narrow.

E. Kingii, Torr. and Gray. Densely matted from many short woody branches at the base: finely tomentose, leaves more rounded, otherwise similar to those of the last: peduncles scapose, slender, several or many, 6–12 in. high, crowned by a capitate cluster of many flowers from few sessile involucels: flowers 1–2 lines long, not short stemmed at base; filaments as in the last.

OXYTHECA. Annual, branching diffusely and dichotomously. Involucres few flowered, in the forks of the branches.

O. dendroidea, Nutt. 6–12 in. high, the single stem erect at base: leaves an ample radical cluster, mostly lanceolate, attenuate-petiolate: finely hirsute-pubescent: branches minutely glandular: bracts at the forks unequal; the involucral segments spinescent awned: flowers a half line long, the inner segments the narrower.—Among sage-brush. June, July.

CHORIZANTHE. Involucre tubular. Flowers minute. Perianth corolla-like and 6-cleft.

C. Watsoni, Torr. & Gray. Annual, 2 or 3 in. high, dichatomously much branched, minutely and often hoary pubescent: leaves basal, few, oblanceolate, an in. or more long, those above bract-like and recurved prickle tipped as are also the unequal segments of the involucre, which is 3 or 4 lines long: perianth minute, tubular, equally 6-cleft, the stamens on the throat.—Dry hard ground. May, June.

IRIDACEÆ.

IRIS FAMILY.

Perennial herbs with equitant, parallel veined, sheathing, radical leaves. Perianth from the apex of the ovary, 6-cleft in two series. Ovary and capsule 3-celled, stamens 3. Growing in wet places.

Flowers large; perianth segments dissimilar, stamens distinct IRIS.
Flowers small; perianth segments similar; stamens united at apex..SISYRINCHIUM.

IRIS. Perianth tube somewhat prolonged above the ovary; outer segments larger, recurved, the inner narrower, erect. Style branches petal-like.

I. Missouriencis, Nutt. Smooth, from a stout rootstock; plants often tufted; stems 1–2 ft. high, bearing the 2 or 3 showy bluish flowers at the apex: leaves 3 or 4 lines wide, linear, a ft. or more long; flowers from a pair of sheathing bracts 2 or 3 in. long, segments of the perianth 2 in. or more long: capsule 1–1½ in. long, broad.—In southeastern part of the valley. May, June.

SISYRINCHIUM. BLUE-EYED GRASS. Perianth 6-parted, the segments equal. Filaments united. Stigma of filiform segments. Capsule sub-globose.

S. bellum, Watson. Stems 10–15 in. high; roots fibrous; leaves grass-like: flowers bluish-purple, few on slender pedicels from a pair of bracts at the apex of the stem, the inner bracts membranous: perianth segments about 4 lines long, cuspidate or 3-lobed at apex, yellowish at base: capsule 2 lines broad.—Very common in the lower meadows during Summer.

LILIACEÆ.

LILY FAMILY.

Herbs with perfect flowers. Perianth mostly corolla-like, 6-cleft or 6-parted. Leaves entire, mostly parallel veined. Stamens 6, opposite the perianth segments. Plants from underground stems.

Perianth of nearly equal distinct segments.	
Flowers rose-colored; from a coated bulb	ALLIUM.
Flowers greenish-white; from a coated corm..........	MUILLA.
Perianth with slender tube............................	LEUCOCRINUM.
Perianth of distinct segments, the outer narrow, inner broad at apex, an inch or more long............	CALOCHORTUS.
Flowers small, numerous, panicled......................	ZYGADENUS.

ALLIUM. ONION. Plants from an underground coated bulb. Flowers numerous in an umbel. Perianth of 6 nearly equal distinct segments. Stamens slender from the base of the perianth segments. Ovary 3-celled. Style slender. Involucre of 2 broad bracts. Capsules obtuse, shorter than the perianth.

A. parvum, Kellogg. Leaves usually 2, linear, very narrow, ½–1½ lines broad, 3–6 in. long; scapes 2–3 in. long, scarcely extending above the surface of the ground: bulb white, ½–¾ in. long, with an ample cluster of fibrous roots at base: umbel an inch or more broad: flowers deep rose colored to purple, 4 lines long, the perianth segments obtuse, exceeding the stamens and style.—In hard ground among sage-brush. Apr., May.

A. atrorubens, Watson. Leaf single, terete, seemingly split at its junction with the scape, 4–6 in. long, sheathing at base: scape slender, terete, 2–4 in. above ground: bulb rose-colored, fibrous rooted at base, usually with one or more lateral smaller bulbs: umbel globose, 1–2 in. broad: flowers rose-colored to purple; perianth segments 5–6 lines long, acuminate, a half longer than the stamens: pedicels half an inch or more long.—In dry places on the foothills. May–June.

A. anceps, Kellogg. Leaves 2 or 3, flat in a vertical plane, about 3 lines broad, 4–6 in. long, falcate: bulb white, ¾–1 in. long, the cluster of fibrous roots at one side of a scar: scape 2–4 in. above ground, flat, margined, 1½–2 lines broad; involucral bracts connate at base: flowers deep rose-colored, 4 lines or more long, obtuse or simply acute, exceeding the stamens and style.—Commonest on light rocky ground. Apr.–June.

MUILLA. Very similar to Allium in general appearance. From a double corm, the lower part flattened and root bearing, the whole surrounded by a membranous coat.

M. transmontana, Greene. Leaves few, not sheathing the stem at base, a line or more broad, 6–10 in. long, scape slender, 6–12 in. long, this and the leaves minutely scabrous: flowers open and in bud at the same time, greenish white, 4 lines long, perianth segments nearly equal, with green midvein; filaments enlarged at base; stigma 3-lobed: involucre lacerate-parted into several segments: capsule globose, 3-celled: seeds several, black.—Common in sandy places. May, June.

LEUCOCRINUM. Stemless from a short rootstock and fleshy fibrous roots 3 or 4 in. below ground. Flowers with long tubular perianth having a 6-cleft limb. Stamens 6, attached in the throat. Ovary and capsule below ground. Seeds several, black.

L. Montanum, Nutt. Leaves several, surrounded at base by broad scarious bracts, lying on the ground, 6–10 in. long, 2–3 lines broad: flowers showy, slightly fragrant, white, half above ground; tube slender, 3–4 in. long; segments lanceolate, an in. long, equaled by the slender stamens, inserted in the throat of the perianth: style 3-lobed at apex.—This is the "sand lily" found in sandy places in April.

CALOCHORTUS. Perianth segments 6, distinct, the outer narrower than the inner. Stamens 6, from the base of the segments. Showy flowers 1–5 in an umbel. From a deep seated corm.

C. Leichtlinii, Hook. 12–18 in. high, corm coated, 6 in. or more below ground, few radical leaves linear, 3–6 lines broad, 6–12 in. long, early disappearing; stem simple with 1 or 2 subulate leaves, 2 or 3 subulate bracts at base of the umbel: flowers greenish-white; pedicels 1–3 in. long: outer segments narrow, scarious margined, the inner cuneate-obovate, 1–3 in. long, an internal purple band above the yellow base, which bears a hairy gland: anthers 3 or 4 lines long: capsule attenuate above, 2–3 in. long.—Among sage-brush. May, June.

ZYGADENUS. Plant stout from a large coated bulb bearing a short rootstock beneath. Flowers numerous, small, in compound raceme below which becomes simple above. Capsule 3-celled, many seeded.

Z. paniculatus, Watson. 1–2 ft. high, bulb 6 in. below ground, rootstock black; leaves sheathing, curved, 6–8 lines broad, folded lengthwise: raceme 6–8 in. long, with subulate bracts: flowers greenish-white, 5 lines long, stamens exserted, perianth segments acute, the outer shorter, capsule 3-lobed longitudinally, the cells ending in a pointed tip.—Common on the hills. April, May.

GLOSSARY.

Acaulescent. Stemless, or without evident stem.
Accumbent. The cotyledons with edges against the radicle.
Acuminate. Ending in a tapering point.
Adnate. Parts congenitally united.
Adherent. Similar in meaning to the preceding.
Akene. A small, dry, one-celled, one-seeded, indehiscent fruit.
Alveolate. Honeycombed.
Annual. Of only one year's duration.
Anther. The pollen-bearing part of a stamen.
Appressed. Lying flat against.
Aquatic. Living in water.
Ascending. Rising obliquely upward.
Attenuate. Very slenderly tapering.
Auriculate. Ear-lobed; as the base of some leaves.
Awn. A bristle-shaped appendage.
Axillary. In or relating to an axil; as between a leaf and its stem.

Beak. A narrow or prolonged tip.
Bearded. Hairy.
Biennial. Of two years' duration.
Bifid. Meaning two-cleft to the middle or nearly so.
Bilabiate, Two-lipped.
Blade. The limb or expanded portion of a leaf or petal.
Bract. A modified or diminutive leaf.
Bracteate. Having bracts.
Bractlet. A small bract, usually on a flower pedicel.
Bulb. A subterranean stem, bearing fleshy scales or coats; as an onion.

Callous. With hard protuberances.

Calyculate. Bearing calyx-like bracts.

Calyx. The flower cup or external envelope of the flower.

Campanulate. More or less bell-shaped.

Canescent. Hoary, usually with gray pubescence.

Capitate. Head-shaped.

Capsule. A dry and dehiscent fruit of more than one carpel.

Carpel. A simple pistil or an element of a compound pistil.

Caudate. Provided with a tail-like appendage.

Caudex. A trunk-like base of a plant.

Cauline. Belonging to the stem.

Chaff. Scale-like bracts; as upon the receptacle of a sunflower.

Ciliate. Marginally fringed with hairs.

Cineraceus. Ash-grayish.

Circumscissile. Cut or separating transversely.

Clavate. Club-shaped.

Claw. The narrowed base or stalk of some petals.

Cleft. Cut half-way down or nearly so.

Coma. A tuft of hairs on a seed.

Comose. Provided with a coma.

Confluent. Blending into one.

Connate. United congenitally.

Convolute. Rolled up longitudinally.

Cordate. Heart-shaped.

Corm. A solid bulb.

Corolla. The internal envelope of the flower.

Corymb. A flat-topped, or merely convex and open flower-cluster of the indeterminate type.

Cotyledons. The first leaves of the embryo, seed leaves.

Crenate. Scalloped.

Cuneate. Wedge-shaped.

Cuspidate. Tipped with a sharp and rigid point.

Cyme. A flower cluster of the determinate type.

Cymose. Bearing cymes or relating to a cyme.

Deciduous. Falling, or subject to fall in season.

Declinate. Bent or curved downward or forward.

Decumbent. Reclining with the summit ascending.

Dehiscent. Opening regularly.

Dentate. Toothed, especially when the teeth do not point forward.

Denticulate. Minutely dentate.

Diadelphous Said of the stamens when they are united into two sets by their filaments.

Dichotomous. Forked in pairs, two-forked.

Diffuse. Widely or loosely spreading.

Digitate. Finger-like, as leaflets rising from a common point.

Discoid. Relating to a disk.

Disk. The tubular flowers in the heads of the Compositæ.

Distinct. Separate, not united.

Dorsal. Relating to the back.

Drupe. A stone-bearing fruit.

Emarginate. The margin notched, usually at the extremity.

Epigynous. Borne on the ovary.

Exserted. Protruding.

Falcate. Sickle-shaped, with curved and parallel edges.

Fascicled. In the form of a bundle.

Fertile. Producing fruit; as an ovary, or pollen-bearing; as a stamen.

Fibrous. Composed or of the nature of fibres.

Filament. The stalk of an anther.

Filamentous. Composed of threads or filaments.

Filiform. Thread-shaped.

Floral. Belonging to the flower.

Foliaceous. Leaf-like in appearance, or bearing leaves.

Foliate. Having leaflets.

Follicle. Fruit of a single carpel, dehiscent along the ventral suture.

Free. Not united to other organs.

Fructiferous. Fruit-bearing.

Fusiform. Spindle-shaped, tapering at each end.

Gamopetalous. The petals more or less united into one piece.

Gibbous. Swelling out on one side.

Glabrous. Smooth, not pubescent or hairy.

Glabrate. Becoming glabrous with age.

Gland. A definite secreting surface or structure on the surface of any part of a plant.

Glandular. (Referring here to glandular pubescence.)

Glaucescent. Somewhat glaucous.

Glaucous. Covered or whitened with a bloom, like that on a cabbage leaf.

Globose. Having or approaching a spherical form.

Glomerate. Compactly clustered, especially a cyme condensed into a head.

Granulate. Bearing grains or grain-like bodies.

Hastate. As a leaf lobed at the base, the lobes directed outward.

Head. A compact cluster of sessile flowers, as in the dandelion.

Hilum. The scar or place of attachment of a seed.

Hirsute. Pubescent with rather coarse or stiff hairs.

Hispid. Beset with rigid or bristly hairs or bristles.

Hispidulous. Minutely hispid.

Hoary. Grayish white with a fine and white pubescence. See *Canescent.*

Hyaline. Thin, transparent or translucent.

Hypogynous. Under the pistil; as the attachment of the sepals, petals or stamens.

Imbricate. Overlapping, like shingles on a roof.

Incised. Cut irregularly and sharply.

Incumbent. When the back of a cotyledon rests against the radicle.

Indehiscent. Not opening regularly.

Inflorescence. The mode of arrangement of flowers.

Insertion. The place where a body is attached to that which bears it.

Internode. The part of a stem between two consecutive nodes.

Involucel. A secondary involucre.

Involucre. Circle of bracts subtending a flower cluster.

Irregular. Exhibiting a want of symmetry of form.

Keeled. Formed to represent a keel.

Laciniate. Slashed; cut into narrow incisions.

Lanate. Bearing long or tangled hairs or wool.

Lanceolate. Lance-shaped, tapering at least to the apex.

Lateral. Relating to or borne on the sides.

Leaflet. A blade or individual part of a compound leaf.

Ligulate. Furnished with a ligule.

Limb. The border; as the edge of a leaf, or as the expanded tube of a corolla.

Line. The twelfth part of an inch.

Linear. Narrow, much longer than wide and the margins parallel.

Lyrate. A pinnatifid form with terminal lobe large, the lateral segments smaller.

Merous. Denoting parts or members.

Monadelphous. Having the stamens united into one set by their filaments.

Mucronate. Bearing a short abrupt tip.

Mucronulate. Minutely mucronate.

Nutlet. A small one-seeded portion of a dry fruit.

Ob. As a prefix, denotes inversely or oppositely.

Obcordate. Inverted heart-shaped, the notch at the apex.

Obconic. Conical, pointed at the base.

Oblanceolate. Lanceolate, but tapering more to the base than to the apex.

Obovate. Ovate with the broader end at the apex.

Orbicular. With a circular outline.

Orifice. Referring to the mouth of the corolla.

Ovary. The ovule-bearing part of a pistil.

Ovate. Of the shape of the longitudinal section of a hen's egg, the broader end at the base.

Ovule. Part of the flower which becomes the seed.

Palea. A chaff-like bract.

Palmate. Segmented at a common point; as at the apex of a petiole.

Panicle. A loose compound flower cluster, such as produced by the branching of the lower pedicels of a raceme.

Papilionaceous. Butterfly-like.

Pappus. The variously formed calyx of the flowers of the Compositæ.

Parietal. Borne on or relating to the wall; as the ovules of an ovary.

Parted. Cut nearly, but not quite to the base.

Pedicel. An ultimate flower stalk, the support of a single flower.

Peduncle. A general flower stalk, supporting either a cluster or solitary flower.

Perennial. Enduring year after year.

Perianth. The floral envelope of a flower consisting of either the calyx, or calyx and corolla.

Persistent. Remaining even on the fruit or over winter.

Petal. A corolla leaf.

Petiole. The footstalk of a leaf.

Pinnate. With leaflets arranged along each side of a common petiole.

Pinnatifid. Pinnately cleft.

Pinnatisect. Pinnately divided.

Placenta. That in the ovary which bears the ovules.

Plumose. Feather-like.

Procumbent. Lying along the ground

Prostrate. Lying quite flat on the ground.

Puberulent. Minutely pubescent.
Pubescent. Clothed with soft downy and short hairs.
Punctate. Dotted with translucent or colored spots.
Pungent. Terminating in a rigid and sharp point; also sharp to the taste, as mustard.

Raceme. An intermediate inflorescence, with lengthened axis and equal pedicels.
Radiate. Bearing rays, or ray flowers.
Radical. Relating to the root or proceeding from near the root.
Receptacle. A portion of an axis forming a common support for a cluster of organs; as in a flower.
Reniform. Kidney-shaped.
Reticulate. In form of a net-work.
Retuse. With a shallow notch in a rounded apex.
Rootstock. An underground stem of root-like appearance.
Rosulate. A rose-like cluster.
Rotate. Wheel-shaped, circular and horizontally spreading.
Rotund. Rounded in outline.
Rugose. Covered with wrinkles.
Runcinate. Saw-toothed, the teeth pointing backward.

Saccate. Sack-shaped, baggy.
Sagittate. Arrow-head-shaped.
Scabrous. Rough to the touch.
Scape. A leafless flower stem from the ground.
Scarious. Thin, membrane-like, and not green.
Scorpioid. A coiled form of one-sided inflorescence; a false raceme.
Segment. One of the divisions into which a plane organ, as a leaf, may be cleft.
Sepal. A calyx leaf.
Serrate. Saw-toothed.
Sessile. Without a stalk.
Setose. Beset with bristles.

Scapose. Scape-like.

Sinuate. With a strongly recessed margin.

Sinus. A recess or re-entering angle.

Spatulate. Oblong, with the lower end attenuated.

Spike. A form of indeterminate inflorescence, with flowers sessile on an elongated axis.

Spine. A sharp-pointed branch.

Spinescent. Ending in a spine or sharp point.

Spur. A hollow slender extension of some part of the flower; as in the larkspur or violet.

Squamellate. Scaly.

Stamen. An element of the pollen-producing part of a flower.

Stamineal. Relating to the stamens.

Stellate. Star-shaped.

Sterile. Barren; as a blossom without a pistil; a stamen without an anther.

Stigma. The part of the pistil (usually the style) which receives the pollen.

Stigmatic. Relating to the stigma.

Stipe. A stalk, as of an ovary.

Stipulate. Possessing stipules.

Stipules. Appendages at the insertion of the leaf.

Striate. Marked with fine longitudinal lines.

Strict. Close and narrow and upright, very straight.

Style. The part of the pistil between the stigma and ovary.

Subulate. Awl-shaped.

Succulent. Juicy.

Suture. A junction or seam of union.

Syngenesious. Anthers united around the style.

Tap-root. A descending primary root.

Terete. Cylindrical or tapering.

Tessellated. In chequer work.

Tetradynamous. With four long and two shorter stamens.

Throat. The orifice of a gamopetalous corolla.
Tomentose. Densely pubescent with matted wool.
Tomentum. Matted wool.
Tortuous. Bent or twisted in various directions.
Torulose. Cylindrical with small contractions and bulges at intervals.

Umbel. An inflorescence having a cluster of pedicels arising from a common point.

Valvate. When parts meet by their edges.
Valved. Provided with parts which separate from the whole at maturity; as parts of a pod.
Venation. Referring to the frame-work of leaves.
Ventral. Belonging to the inner face, or front.
Verticillate. Arranged in a circle about the axis.
Villous. Bearing shaggy, long and soft hairs.
Viscid. Sticky, retaining particles, etc.

Whorled. See *Verticillate.*

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IRRIGATION.

NEVADA STATE UNIVERSITY.

◆

Agricultural Experiment Station.

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RENO, NEVADA, DECEMBER, 1894.

IRRIGATION.

NEVADA STATE UNIVERSITY.

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THE DIRECTOR,

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IRRIGATION.

R. H. McDowell.

The certainty of a sufficient water supply that can be used at the right time, thereby insuring mature crops of full weight per bushel (Colorado oats—raised by irrigation weighed 48 pounds per bushel, and a special cleaned half bushel weighed 27 pounds and 8 ounces) and above average yield per acre, is the strong factor in favor of irrigation, as compared with the uncertain method of growing crops with alternate seasons of drouth and excessive rain.

This is the theoretical programme for irrigation, and is the practical as well—granting that we have the usual snowfall in the mountains and the best management, that well-directed effort can secure, in ditch construction and the measurement and distribution of water.

Accompanying irrigation is a climate, of almost cloudless skies and limited rainfall, that materially favors the securing of both grain and hay in prime condition. The threshed grain, in plumpness of kernel and freedom from discoloration, presents a marked contrast to that raised in a section of rain—subjected to alternate showers and sunshine at harvest time.

Ditches when once constructed on a true grade become—with a moderate annual outlay for cleaning—landmarks for years. The cleaning of ditches can be largely avoided by using iron or wooden pipes for transfer, with junctions at necessary points for taking water in various directions from the main ditch. Pipes would eliminate seepage—estimated by a California writer on irrigation at 30 to 70 per cent. in newly made ditches, and from 12 to 25 per cent. for those that have been used for several years—and evaporation. In many instances crops could be raised over the pipes, instead of losing the use of two acres of land for every mile of ditch averaging one rod in width. The open ditch is always a source of annoyance and loss in farming operations, not only in the amount of bridging necessary for crossing, but the winding course of the ditches puts a portion of the fields in an awkward shape for working. Those who do not care to use pipes can prevent seepage by cementing the bottom and sides of the ditch; this can be done on the earth itself in those sections that have little or no frost. Where there is freezing a backing of stone or sand may be necessary. Water, like any cash commodity, should be constantly managed with an intelligent determination to make every dollar's worth count. Study well the question: Am I using too much water for the benefit of the crop, or, in the long run, for the good of the land?

FURROWS.

In applying water to grain plats we use furrows instead of "flooding." The latter plan is used in some parts of the west both for grain and alfalfa. In Nevada both plans—flooding and furrows—are used. These light furrows, that are made about thirty inches apart, from four to six inches wide at the top and five to six inches deep—should be made before the grain sprouts in order to disturb the growth as little as possible. In those States having sufficient rainfall to germinate grain and bring it to a height of fifteen inches before the first irrigation, and where two irrigations mature the crop, flooding is attended with satisfactory results. Where irrigation is necessary to germination there is less tendency to "bake" by the furrow than by the flooding system. Furrows for irrigation can be made with a light plow having a single, small shovel, or, as is sometimes practiced, by using the frame of an old mowing machine—wheels, axle and tongue—with a 4x4 fastened under the tongue, and extending back of the driver's seat, to which is attached a similar piece of timber that carries the shovel. The bent axle in connection with a lever throws the shovel out of the ground or holds it to a gauged depth.

This form of furrowing machine is drawn by two horses, and in some cases has been sold for sixty dollars. For two years we have not furrowed our small plat of alfalfa, of about four and a half acres, excepting in limited areas that are slightly higher than the rest of the plat. Where the fall is sufficient to move water over the field in a reasonable length of time, allowing irrigation by flooding, the labor of furrowing is saved and we have a much better surface for working a machine. In portions of the west thousands of acres of alfalfa are raised and the irrigation is entirely by flooding.

"CHECKS."

In irrigation it becomes necessary to stop a portion or perhaps the entire sub-stream, that has been taken from the main ditch crossing the farm. "Checks" are used for this purpose. These may be dirt, small boxes or canvas—the latter is sometimes spoken of as a canvas dam. Some of the most practical men, in the application of water in the field, prefer the first-named check. The material for this class is always at hand.

The extra labor attending the placing of the dirt check and its removal to allow the head of water to pass to the next section to be irrigated, and the fact that it sometimes washes out (one of Colorado's best men in the field says, "I never have a dirt check wash out") are the chief objections to its use.

The second named, small boxes, are a cheap and convenient form of check that can be made of rough lumber at odd times. The size varies with the size of the stream. For small streams a box from 18 to 24 inches in length and 10 to 12 inches wide will do the work. These boxes are provided with a gate that stops a portion of the stream or the entire stream and forces it out at the side of the box, changing its course at right angles. The boxes are easily moved and placed in position when needed in another part of the field. The third form of check, the canvas, is of slight cost and easily made—by using a grain sack and a piece of wood two inches in diameter, fastened across the end of the sack and about two feet longer than the width of the stream. The canvas is more readily changed from one part of the field to another than either of the other checks and has strong advocates among the field men.

WHEAT WITH THE NUMBER OF IRRIGATIONS VARIED.

For the seasons of '93 and '94 a variety of wheat called Gypsum was drilled in sections of one-fortieth of an acre each to note the growth and yield with the number of irrigations varied. Drilling was done May 11th, in 1893, and April 26, 1894, at the rate of 75 pounds per acre. The growth was good both seasons. The increased yield in '94 as compared with the same, or a less, number of irrigations in '93, is largely due to the heavy manuring the plats received at the opening of the season of '94. The earlier sowing in '94 may have exerted a favorable influence.

The results are given in tables No. 1 and No. 2.

Table No. 1—Wheat—1893.

Number of Irrigations Varied.

NAME.	Area—Acres	No. irrigations	No. of Section	Date ripe	Yield.			
					Per Plat.		Rate per Acre.	
					Lbs.	Oz.	Lbs	Oz.
Gysum	1-40	8	1	8-25	48	12	1950	....
Gysum	1-40	7	2	8-25	44	5	1772	8
Gysum.	1-40	6	3	8-25	39	2	1565	....
Gysum	1-40	5	4	8-24	44	14	1795	....

Table No. 2—Wheat—1894.

Number of Irrigations Varied.

NAME	Area—Acres	No. Irrigations	No of Section	Date Ripe	Yield.			
					Per Plat.		Rate per Acre.	
					Lbs.	Oz.	Lbs	Oz.
Gysum	1-40	7	1	8-13	63	10	2545	....
Gysum	1-40	6	2	8-13	57	6	2295	....
Gysum	1-40	5	3	8-13	57	6	2295	....
Gysum	1-40	4	4	8-11	49	2	1975	....
Gysum	1-40	3	5	8-11	45	15	1837	8

WHEAT—IRRIGATIONS VARIED; 1 AND 2.

In testing a new grain drill a small area of wheat was sown between the rows of apple trees. As the wheat came up well—although the ground had not been fitted—it was decided to irrigate a portion once and the remainder twice. One forty-seventh of an acre that received one irrigation yielded 14 pounds, 4 ounces, or at the rate of 669 pounds 12 ounces per acre. One-sixtieth of an acre that was irrigated twice yielded 12 pounds 15 ounces, or 776 pounds 4 ounces per acre.

POTATOES WITH THE NUMBER OF IRRIGATIONS VARIED.

Table No. 3 gives the weights of potatoes with the number of irrigations varied. Potatoes have been irrigated once in two days, or twenty-nine times during the season. At variance with the advice of all growers, we have flooded them. Those that were irrigated once in two days and another section that was flooded, came out in good condition at harvest time It does not necessarily follow that this would be the result in a heavy clay soil. Our soil is sandy with a gravel subsoil.

Table No. 3—Potatoes.

Number of Irrigations Varied.

NAME.	1—Half potato. 2—Whole potato....	No Hills Planted...	Number of Hills Germinated........	No Irrigations.....	Yield Large.		Yield Small.		Yield calculated to 36 hills for large potatoes......	
					Lbs.	Ozs	Lbs	Ozs.	Lbs.	Ozs
Early Rose	1	36	27	3	65	12	9	8	68	3
	2	36	36	3	97	10	14	8	....	....
Early Rose	1	36	35	4	79	4	11	8	81	8
	2	36	36	4	119	10	15	8	....	....
Early Rose	1	36	34	5	107	10	9	8	110	12
	2	36	36	5	121	2	14	8	....	....
Early Rose	1	36	34	6	100	....	14		102	15
	2	36	36	6	123	10	14	8	....	....

CORN WITH THE NUMBER OF IRRIGATIONS VARIED.

Corn, with the number of irrigations varied, has been on trial but one season. All sections were frosted September 13th. Sections 5 and 6, at the rate they were advancing, would have ripened—without frost—about September 15th or 16th. Sections 1 and 2 maintained a steady growth, while No. 3, at times, showed the lack of water. No.

4 produced (for this season) greater weight of stalks, but was uneven in growth;. severely wilted at times and then revived after irrigation. Sections 5 and 6 were uneven and stunted in growth. Ears were set near to the ground, and the call was for more water. There were nine rows, each 132 feet in length, to each section. (Approximately 1-40 of an acre.) Three to five irrigations will raise fodder with some ears, but the indications are—for our soil—that seven to eight irrigations will be required for an even growth.

One row, in section 6, was weighed separately as it plainly showed the effect of seepage, although it was four feet from the center of the sub-ditch. The rows were three feet apart each way and each hill was thinned to three stalks.

Table No. 4—Corn.

Number of Irrigations Varied.

NAME.	Date Planted	No. of Section	No. Irrigations	Date Ripe	Height—Inches	No. Rows Planted	Yield.			
							Weight of Ears.		Weight of Stalks.	
							Lbs.	Ozs.	Lbs.	Ozs.
Pride of the North	5-10	1	8	9-6	60 to 63	9	263	1	353	7
Pride of the North	5-10	2	7	9-8	73 to 84	9	260	....	372	8
Pride of the North	5-10	3	6	9-11	68 to 84	9	209	9	326	7
Pride of the North	5-10	4	5	9-13	65 to 82	9	132	....	395	....
Pride of the North	5-10	5	4	....	68 to 77	9	149	7	261	9
Pride of the North	5-10	6	3	....	52 to 54	8	114	15	229	1
						1	18	12	30	4

One of our able authorities on irrigation is Prof. L. G. Carpenter of Colorado, who kindly forwarded data on irrigation in reply to the following questions:

1. Will you give a few examples showing the present status of windmill and steam irrigation in Colorado?

2. How large a place can be irrigated—and at what cost for the plant—with windmill or steam? Which is most in favor with farmers? Also, would like cost of two to four of the largest ditches in Colorado with length, depth, width and grade per mile. We are also indebted to Prof. Carpenter for the loan of cuts showing the spill-box and water divisor.

In a certain field, pumping will play an important part, but it will be rarely that the conditions will be favorable enough to displace irrigation by gravity supply; probably in no place where the water supply is good. With pumping there is always a constant expense, which for coal and hauling, and for extra attendant, may become quite large during the course of a season. For wheat and alfalfa the returns hardly pay for the added expense; for crops which are more profitable, pumping may pay.

Where used here, it is more generally for supplementing the gravity supply which is inclined to fail during the latter part of July and August. This means that some of the most profitable crops either cannot be grown, or else that the yield will be poor. This is true of the potato crop in this valley as you know. This need has led to the construction of reservoirs on a large scale, and the same cause has led some to pump. In some of these cases the results have been satisfactory; in most, the results have not been satisfactory. I have sent out blanks during the past fall to all that were pumping, of whom I could learn. A sample of the blank is enclosed. As above said, I think that pumping will be useful and profitable in many places, but I should hesitate to recommend it indiscriminately. Where steam can be used on a large enough scale, it ought to at least pay to pump water to a considerable height, but under the actual conditions few derive as much benefit as they anticipate. The incidental expenses are greater than they had thought. The water to be raised is so much dead weight, and every increase of a foot to the lift adds so much to the work to be done to furnish water to a given area, or diminishes the amount of water raised with a given power. This quantity of work would be the same irrespective of the kind of plant But by far the greater part of the power of the coal is expended uselessly, and with the small plants generally used, there must always be a great deal of waste. But even under as wasteful conditions as these, it might not be too expensive if other conditions are favorable and the management is good. Thus, with one of the plants where the experience was satisfactory, there was 174 tons of coal used during 50 days Now aside from the cost of the coal, this all needed to be hauled, which in itself requires labor and expense. Many do not figure up the coal, and think, in considering the hauling, that this can be done at odd times and need not be counted as cost. But it is found that the hauling is a considerable item, especially if the haul is of any length. Most of the hauling has to be done in the summer when time is valuable. This then adds to the expense.

If a steam engine is used, an extra man is generally needed to attend to the firing and the engine. If now in addition something gets out of order, then with repairs at some distance, and with a lack of skilled labor, or at a high rate, the annoyance and expense may be so great as to lead to its abandonment These have been some of the causes which have caused dissatisfaction with pumping with many who have tried it, where had they looked into the question more fully in the first place, they would either not have attempted it, or knowing what to expect, could not have been so keenly disappointed. Some of those who thus started pumping, would have been well satisfied had they known the full conditions in advance, but as it is, they dropped the attempt in disgust.

Because of the great expense of hauling coal, and the skilled labor needed to fire and run the engine, (it is too commonly thought that "any one can fire,") I have felt that some of the forms of gasoline engines might give the best form of power for isolated plants. There are of course many forms of these, some objectionable, some not. But the fuel which these use occupies little bulk—10 gallons of gasoline in the better engines furnishing power for a 10-horse engine for 10 hours, and if in good condition the engines or some of them do not need personal attention for several hours at a time. This would remove two of the big items of expense, or reduce them very much.

Now between steam, or engine power, and windmill irrigation, the scope of the windmill is generally for irrigation on a small scale. Most of the windmills furnished do not have power enough to furnish much water at any height. Of course they will furnish water enough for a large number of stock, but the amount of water which will satisfy the needs of a thousand cattle, will not go very far in irrigation. A windmill answers very nicely for garden patches, or an acre or two about the house, but as yet with the patterns in ordinary use, is not capable of irrigating to a very great extent. It is, however a very cheap source of power, requiring few repairs, and limited by the varying speed of the wind. A 14-foot wheel may be considered as yielding one-quarter horse power (makers often claim much more) with a wind blowing 18 miles per hour, less, of course, with lower velocities, the effect of higher velocities is probably not much if any greater, because most of the wheels are thrown out of action with a high wind. Now, one-quarter horse power means work enough to raise about two cubic feet of water one foot high in one second. If it is a lift of 20 feet, the amount of water is proportionately reduced, being then about one-tenth of a cubic foot per second. If the water is to be lifted still higher, the amount which could be lifted would be still less, etc. As the wind is constantly varying, a windmill needs a reservoir or storage tank, even for stock supply.

The Northern Colorado Canal (the high line) near Denver, length about 80 miles, cost in round numbers $700,000. This was an expensive canal.

The Arkansas Land Reservoir and Canal Co., 108 miles long, 35 feet wide at the head, fall 18 feet per mile, carries about 700 cubic feet per second, cost $250,000.

The Lamar Land and Canal Co., 53 miles long, 30 feet wide at head on bottom, grade 2.40 for 19 miles, less after that, cost $100,000.

Pleasant Valley and Lake, Ft. Collins, (high line) 18 miles long, 16 feet wide, cost for part outside of foothills, $26,000. They have expended all told perhaps $70,000.

Cach la Poudre No. 2, 26 miles long, 30 feet wide at head, grade 2 feet, cost $63,000. Appropriation is 585 cubic feet of water per second.

FORT COLLINS, Colorado, 1894.

DEAR SIR: In a considerable portion of the State it is recognized that pumping for irrigation purposes is or will be of considerable importance. A considerable number have been pumping more or less. Their experience, whether favorable or unfavorable, will be useful to others. In order to collect the experience of those who have tried pumping, the following blank is sent out, and your aid is asked in filling in the questions with information regarding your own plant.

Please do not hesitate to send it in, even if you cannot answer all the questions, and no matter whether your experience has been favorable or unfavorable.

A copy of the results when collated, with other information, will be sent to each who may aid in the collection of information.

Other information is desired concerning the water supplies of the Plains portion of the State, of wells or other sources. The aid of yourself and others is solicited for this object.

Very Respectfully,
L. G. CARPENTER,
Professor Irrigation Engineering

1. Do you pump water for irrigation purposes? Yes.

2. What kind of pump and power? Centrifugal pump and steam engine.

3. How many acres do you irrigate by pumping?........................
What crops? (No of acres of each).......   ....

4. Do you depend entirely on pumping, or for part of season only? All pumped for potatoes.

5. How many irrigations by pumping? Four.

The water is raised 16 feet (from surface of water in well to mouth of discharge pipe). It is forced....feet horizontally through 6 inch pipe. On the average 5 acres are irrigated per day; the best record has been 5 acres in ten hours.

The pump is of what kind? Centrifugal. The barrel is........in. long.........in. diameter. It is run at the rate of......strokes per minute

The power used is? Ten h. p. engine. (If windmill, give type of wheel, diameter of wheel, and height above ground)................
It has used, 1,200 lbs of ....coal in 12 hours. The coal cost $1 75 per ton delivered at bank (mine) which is five miles from pump

The expenses of pumping have been:
For attendance (engineer, fireman)....men at $....per day. $ ..
Hauling coal,..days man and team estimated at $....per day, $....
Oil, repairs and... $....
Coal........tons at $.. $....

Total for twelve hours run $3 10

We have irrigated....acres....times, making cost for the irrigation of one acre (aside from interest on cost and depreciation of plant)....

The well is........ft. diameter........ft. deep. The water is found in a layer of........which is......ft. thick. The water stands ....ft. deep in well before pumping.

Does continuous pumping lower water in well?.............   ...
The cost of well was........... .... $....
" " " power was, engine........................... $ 450
" " " pump was, pipe shaft...................... ... $ 150
Other expenses... $....

The total cost has been. .... $ 600

Please state whether you have found pumping satisfactory or not. Very satisfactory for potatoes, and then I have a lake to pump out of so there is no scarcity of water.

Name, W. S. Baldridge.
Address, Eaton.

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1. Do you pump water for irrigation purposes? Yes.
2. What kind of pump and power? Windmill, 1 in. pipe.
3. How many acres do you irrigate by pumping? One. What crops? (No. of acres of each). Garden.

4. Do you depend entirely on pumping, or for part of season only? Yes.

5. How many irrigations by pumping?........................

The water is raised 132 ft. (from surface of water in well to mouth of discharge pipe). It is forced....ft. horizontally through....in. pipe. On the average....acres are irrigated per day; the best record has been....acres in....hours.

The pump is of what kind? Common stock. The barrel is.... in. long,....in. diameter. It is run at the rate of....strokes per minute.

The power used is.................. (If windmill, give type of wheel, diameter of wheel, and height above ground). Ten ft. wheel, 30 ft. high. It has used....tons of..........coal in....days of.... hours each. The coal cost $....per ton delivered at... .... which is........miles from pump.

The expenses of pumping have been:

For attendance (engineer, fireman)....men at $.... per day $....

Hauling coal...days man and team estimated at $.... per day $....

Oil, repairs and.............................40c per year.

Coal,........tons at $.................... ....$ ....

Total ....$ ....

We have irrigated....acres....times, making cost for irrigation of one acre (aside from cost and depreciation of plant)................

The well is........ft. diameter,........ft. deep. The water is found in a layer of........which is........feet thick. The water stands 2 8 10 ft. deep in well before pumping.

Does continuous pumping lower water in well?.................

The cost of well was.................................. $....

" " " power was.................................. $ 54

" " " pump was.................................. $ 42

Other expenses.. $ 7

The total cost has been.................................. $ 103

Please state whether you have found pumping satisfactory or not. It has been, as I have had nothing else outside of garden.

Name, B. E. Lewis.

Address, Uray.

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1. Do you pump water for irrigation purposes? Yes, sir.

2. What kind of pump and power? Three common pumps, each 3x10 inches, cyl., each fitted with 1¼ inch pipes.

3. How many acres do you irrigate by pumping?..........What crops? (No. of acres each). Strawberries, beets, garden truck.

4. Do you depend entirely on pumping, or for part of season only? Entirely.

5. How many irrigations by pumping?........................

The water is raised 30 ft. (from surface of water in well to mouth of discharge pipe). It is forced....ft horizontally through....in. pipe. On the average....acres are irrigated per day; the best record has been .. acres in....hours.

The pump is of what kind? Common hand. The barrel is....in. long,....in. diameter. It is run at rate of 30 to 40 strokes per minute.

The power used is Airmoter, 8 foot wheel. (If windmill, give type of wheel, diameter of wheel. and height above ground. Twenty-six feet.

It has used....tons of..........coal in....days of....hours each. The coal cost $....per ton delivered at.......... which is...... miles from pump.

The expenses of pumping have been:

For attendance (engineer, fireman)....men at $....per day $....
Hauling coal..days man and team estimated at $....per day $....
Oil, repairs and .... $....
Coal..........tons at $.. $....

Total.... .... $....

We have irrigated........acres........times, makine cost for the irrigation of one acre (aside from interest on cost and depreciation of plant)..

The well is .....ft. in diameter,......ft. deep. The water is found in a layer of..........which is..........ft. thick. The water stands 2 5 12 ft. deep in well before pumping.

Does continuous pumping lower water in well?.................

The cost of well was. ....$ 16
" " " power was...$ 40
" " " pump was...$ 6
Other expenses...$ 8

Total cost has been. ....$ 70

Please state whether you have found pumping satisfactory or not. Have found it O. K.

Name, J. D. Graham.
Address, Julesburg.

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1. Do you pump water for irrigation purposes? Yes.
2. What kind of pump and power? Dempster windmill and pump.
3. How many acres do you irrigate by pumping? One. What crops? (No. of acres of each). Garden cabbage, tomatoes, melons, beets, turnips.
4. Do you depend entirely on pumping, or for part of season only? This season altogether.
5. How many irrigations by pumping? Once a week.

The water is raised 120 ft. (from surface of water in well to mouth of discharge pipe). It is forced 6 ft. horizontally through 1 inch pipe. On the average....acres are irrigated per day; the best record has been......acres in......hours.

The pump is of what kind? Dempster. The barrel is....in. long, ...in. diameter. It is run at the rate of....strokes per minute.

The power used is one 8-foot wheel. (If windmill, give type of wheel, diameter of wheel, and height above ground). Twenty-four feet. It has used ...tons of..........coal in....days of....hours each. The coal cost $ ...per ton delivered at..........which is ....miles from pump.

The expenses of pumping have been:

For attendance (engineer, fireman)....men at $....per day $.

Hauling coal..days man and team estimated at $....per day $.

Oil, repairs and.. $.

Coal..........tons at $.................. .... $.

Total............................ .... $.

We have irrigated....acres....times, making the cost of irrigating one acre (aside from interest on cost and depreciation of plant)....

The well is....ft. diameter, 120 feet deep. The water is found in a layer of..........which is......ft. thick. The water stands... ft. deep in well before pumping.

Does continuous pumping lower water in well? No.

The cost of well was....................................$ 82

" " " power was. .. ..$ 55

" " " pump was...................................$. ..

Other expenses.. $. ..

The total cost has been.............................. ...$ 137

Please state whether you have found pumping satisfactory or not? Yes, sir. We raised the only garden in this part of the county, and as good one as could be seen in any country.

Name, Lafe Wagner.

Address, Yuma, Colorado.

Two Farms and Two Wells.

1. Do you pump water for irrigation purposes? Yes.

2. What kind of pump and power? One Van Wye Centrifugal and one Menge Patent Pump.

3. How many acres do you irrigate by pumping? Four hundred. What crops? (No. of acres of each). Wheat, oats, potatoes and alfalfa.

4. Do you depend entirely on pumping, or for part of season only? Entirely.

How many irrigatious by pumping? One to six.

The water is raised 30 feet (from surface of water in well to mouth of discharge pipe) when well is pumped down. It is forced....ft. horizontally through....in. pipe. On the average 15 acres are irrigated per day; the best record has been 20 acres in 11 hours by one well.

The pump is of what kind? Centrifugal and Menge. The barrel is ....in long,......in. diameter. It is run at rate of 300 revolutions per minute

The power used is steam boiler and engine 30 h. p. (If windmill give type of wheel, diameter of wheel and height above ground). It has used 174 tons of Soft Eaton coal in 50 days of 12 hours each. The coal cost $1 50 per ton delivered at mine, which is two and a half miles from pump.

The expenses of pumping have been:

For attendance (engineer, fireman) two men, one at each pump at $1 50 per day for fifty days	$ 150
Hauling 20 days man and team estimated at $3 per day	$ 60
Oil, repairs and	$ 35
Coal, 174 tons at $1 50	$ 261
Total	$ 505

We have irrigated 225 acres four times, making the cost of one acre (aside from interest on cost and depreciation of plant) $2 25

The well is 12 ft. in diameter, 28 ft. deep. The water is found in a layer of gravel which is 28 feet thick. The water stands 25 feet deep in well before pumping.

Does continuous pumping lower water in the well? Yes. Down to a certain limit at which the pump is supplied.

Cost of 1 plant.	The cost of well was	$ 700
	" " " power was	$1,000
	" " " pump was	$ 275
	Other expenses	$ 125
	The total cost has been	$2,100

Please state whether you found pumping satisfactory or not. I have found it very satisfactory. One great advantage is being able to get water when needed.

Name, Andrew Wilson.
Address, Eaton, Colo.

The following extract from Bulletin No. 27, Colorado Station, "The Measurement and Division of Water," is presented to our people with the single idea of allowing them to compare notes with our neighbors who use irrigation. Also to read the conclusions of the British Commission after having examined the subject of irrigation in several countries. Citizens of Nevada, in a practical way, have—in forty years past—done much with irrigation. Yet it is well to talk with our neighbors on this question—compare their practice with our own—and then decide how we stand on the subject of irrigation as it is to-day.

Questions concerning the measurement and distribution of water probably give rise to more trouble than all others combined in an irrigated country. While frequently the matter in dispute is of small consequence, it is a source of irritation that causes constant annoyance both between canals and consumers, and between neighbors. The problem of a just distribution of water is one of the most important as well as one of the most difficult problems of irrigation.

In passing over the lines of ditches in Colorado and in other States, and in other countries, I have made their methods a special object of observation and inquiry. In general it may be said that the prevailing methods are exceedingly unreliable. In some canals, even the large ones, there is little attempt save by the eye or the judgment of the ditch rider; in others there are nominal measures which frequently are worse than none at all, because while giving no approach to a proper measurement, they give among the consumers and canal officers a false sense of accuracy and stand in the way of a better system. In others the systems are as good as the conditions will permit. When water has been plentiful in the streams there has been no necessity for close division or measurement, for there has been water enough to supply the demands of all. But with the greater demand for water, and the need by each farmer of every drop obtainable, there is greater necessity for closer measurement, and many canal organizations are being led to consider more efficient means of measurement and distribution.

The prevention of waste is a matter of public importance. With more land than water, the agricultural future of Colorado depends on the use of her existing water supply to its fullest capacity. The building of storage reservoirs, the stopping of waste, improved methods in irrigation, together with the changes consequent on irrigation, which make less water necessary, will increase our water supply in effect, if not in amount.

It is safe to say that a good system of measurement will save a large amount of water. Every one knows that in financial affairs a close account is the basis of sound economy. It is also true in water matters. The mere fact of measurement makes users more careful about waste, and in the aggregate the saving is considerable, as some cities which measure water to consumers have found. With water plentiful, the system, or lack of system, works without friction. The practice is to give enough to stop complaint, if there is water enough. But as water becomes scarcer and the demand greater, then the system works gross injustice. If some one gets more than his share, it means that some one else gets less. And this may mean ruin to his crops. In many parts of the State the pressure for water is already being felt. It is only a question of time when the other localities will feel the same pressure, and with time, all will feel the demand more. Hence it is that there will never be an easier time for arranging satisfactory measurements than now; for the demand will not be less, and with time and the increase in value of water then there will be many who will feel that they have rights vested in certain methods of measurement which may be intrinsically unjust.

This bulletin is the result of the consideration of the measuring devices forced upon my attention by various trips over the canals of this State. The study has extended, especially since the first edition, to devices in use in other States and in other countries than our own, in the hope of finding a device which should meet all the desirable conditions. It cannot be said that any are free from objection, but there are some which can be recommended, and, since even on some canals with a presumed system of measure I have found discrepancies amounting to as much as 400 per cent., there is much room for improvement. It may be said, with the present knowledge, there is no need for the variation to be more than 10 or 20 per cent., except in occasional cases, and it is scarcely necessary to except these.

On this subject, as well as on others in the line of irrigation, the experience of Italy is useful. Her physical conditions are not so far different from ours. She has the accumulated experience of six centuries with irrigation; we of scarcely thirty years. While the progress made here by a people who had to rely on themselves for their knowledge of irrigation has been marvelous, it is unquestionably true that we may learn much from her experience. The physical laws governing the flow of water, the principles involved in distribution and measurement are the same here as there. We are finding the necessity of laws and regulations which they long ago found necessary. We shall find it necessary to take other steps which their experience long ago showed desirable.

The Italian modules have been various, but until recently most of them have been based upon one idea—an erroneous one—which has been introduced into Colorado and the other western States, in the form of the various miners' inches.

The need for measurement was felt before there was more than the most limited knowledge of hydraulic laws, and the methods of measment date back, consequently, before the rise of hydraulic science. That they have been used for several centuries with even a fair degree of satisfaction reflects great credit upon Soldati and the magistrates of Milan who so firmly grasped the conditions of the problem. That these measures are known to be incorrect is shown by the fact that all of the large modern canals have adopted other systems. The Cavour Canal, the Canale Casale, the Canale Villoresi have all adopted systems depending upon the weir. The insufficiency of the old measurement is evidenced by the fact that the Italian government required in one of its acts of concession granting water to a new canal, a plan for a new module for the measure and sale of water. That the old measures are still used, and will be used, is due to the fact that in time the individual users have acquired rights in the water which that particular method allows them, and any change which threatens those rights arouses at once intense opposition. The same kind of conservatism is shown in Colorado, and the same varied customs are growing up. There are already numerous canals on which there are several different methods of measurement in use and where water is measured out differently to the early users. The change effects the new users.

The module proposed and adopted by this canal—the Canale Villoresi—will be especially described, because it seems to dispose of some of the difficulties which have made the weir objectionable.

In the measurement of water there are two distinct classes of measuring boxes, different in their object. One is the dividing box, whose object is to give to each consumer some definite portion of the water flowing in the ditch. This box is found especially in the laterals owned in common by two or three neighbors, or in the smaller canals owned and operated by the stockholders. The other class is the measuring box, which has in general for an object to give the consumer a certain definite quantity of water, as one cubic foot per second. These need to be adjustable, so that in times of scarcity the amount may be reduced proportionately as the quantity in the canal decreases. To this last class the Italians give the name of *modulo*. The French writers on irrigation, and to a limited extent the English, have adopted the word in the form of *module*, and, as such a word is needed in our irrigation vocabulary, the term is used here *Module* will therefore be used to designate those boxes or devices, whatever their form, whose object it is to measure the quantity of water delivered, or to give a constant flow. The word *divisor* will be restricted to the first class, whose only object is to divide the water. A module may evidently serve as a divisor, for if the amount to be divided is known it is a simple matter to determine the quantity to which each is entitled and to regulate the module accordingly. There will always be cases where divisors will be by all means the most convenient, but these cases will be mostly in the small ditches from which few take water. In all other cases modules of one kind or another will be found the better.

In the case of divisors it is evident that there is no unit of measure, and that none is needed, as the object is to give the consumer some definite portion of the water flowing in the ditch whether there be much or little.

In the module, on the contrary, some unit is needed.

It is unfortunate that a system has grown up in which the professed unit is the "inch." The word is used in such a multitude of meanings that it is an almost hopeless task to convey an exact idea of quantity by the word. It in effect takes into account only the cross-section of the channel or opening, without regard to the velocity of the water. In the same ditch it is attempted to have the velocity the same or nearly the same through the different openings, by keeping the head the same, but in different ditches the heads vary according to convenience or the notions of the original users In some ditches the head is four inches, in others six, in some eight, and there are others which allow the opening to extend to the surface of the water and no pressure is used. The whole area of the opening in square inches is then counted as inches of water. Also, in common use, a practice has grown up to call the cross-section of the stream in square inches, without regard to the velocity of the water, as so many "inches." Manifestly there is nothing in common in these different inches, so that the term has no definite meaning. The legal "inch" of Colorado, as defined by Section 3472, General Statutes, and which was defined in 1868, is as follows:

"Water sold by the inch by any individual or corporation shall be measured as follows, to-wit: Every inch shall be considered equal to an inch square orifice under a five-inch pressure, and a five-inch pressure shall be from the top of the orifice of the box put into the banks of the ditch to the surface of the water; said boxes or any slot or aperture through which such water shall be measured, shall in all cases be six inches perpendicular, inside measurement, except boxes delivering less than twelve inches, which may be square, with or without slides; all slides for the same shall move horizontally, and not otherwise; and said box put into the banks of the ditch shall have a decending grade from the water in ditch of not less than one eighth of an inch to the foot."

But in addition to the variation in use, there is another fundamental error in the method, which long ago being recognized by the users in Italy, caused them to prohibit the use of openings of more than a certain number of oncia. According to this system an opening 6x16, for example, would give 96 "inches;" one 6x8 would give 48. One should discharge twice as much water as the other. As a matter of fact the one discharges considerably more than twice as much as the other. This is true, even if the conditions of the head are the same. It was noticed by the users of Italy, so that long ago the number of inches which could be drawn through one opening was limited. If one observes the discharges from an opening under good conditions the reason will be seen. As the water passes out, there is a narrowing up of the stream on top and bottom and sides. As ordinarily placed, those on the sides are the most noticeable. Now the total amount of this narrowing is approximately the same whether the opening is long or short, provided the head is the same. Hence the amount is decreased nearly the same in both cases. But relatively the loss from the smaller one is greater than from the large one, and the consequence is that the large one discharges more than twice as much as the smaller one. The place where the velocity is the same, with the head, is not at the opening itself, but where the cross-section of the issuing stream is the smallest. To illustrate further: Suppose that with the statute inch the contraction at each side is one inch; then with the opening six inches high, each area loses 12 inches, reducing the effective area of the one from 48 to 36 square inches and of the other from 96 to 84 square inches, and, leaving other considerations out of account, then the ratio between the two is more nearly that between 84 and 36, or 2.3, than between 96 and 48. In this particular case the larger user receives 2.3 as much as the smaller one, though it is considered as only twice as much. This cause is sufficient to make the "inch" differ by more than 50 per cent. With the indefiniteness of the term as used, it is difficult to determine a clear idea of the quantity involved, unless the statute establishing the ratio between the statute inch and the cubic foot per second in such terms as to make 38.4 statute inches equivalent to one cubic foot per second should be considered as defining the inch. This ratio may be very widely variant if the inch is measued according to statute terms. The cubic foot per second is an absolute unit whose quantity cannot be subject to dispute, though the accuracy of measure may be. The State laws provide that in appropriating water to ditches the quantity shall be estimated in cubic feet per second, or as frequently shorter expressed, as second feet.

DIVISORS.

As ordinarily constructed, the division can rarely be exact, but, frequently, the convenience of an approximate division more than counterbalances any inaccuracy there may be. The larger ditches rarely have occasion to use divisors, for, even if the ditch has to pro rate the water, a better distribution can be effected by use of modules. If the water is to be divided into two equal portions, by placing the two lateral ditches in identical relations to the main ditch, in a straight and uniform channel, the division is exact. Emphasis should be laid on the *identical* relation, for many divisions are seen where the conditions are not the same, as *e. g.*, one branch continues straight, the other may make an abrupt turn, one may pass through a covered box, etc. In these cases some advantage is given to the ditch having the freer discharge. The effect of these differences is greater than is generally supposed. It is, however, generally easy to meet these conditions if the parties desire. In the same way the water may be subdivided into four, eight or sixteen equal parts. But where it is required to divide the water into two unequal or into three or more portions, equal or not, the division becomes one of approximation only. The difficulty arises from the fact that the water has not uniform velocity across the whole channel, the center has greater velocity than that near the banks. If, therefore, equal openings be made across the channel, those near the center have the greater discharge. Making the central openings smaller only partially evades the difficulty, for as the relative velocities of the center and sides differ with different depths, this arrangement would still be inexact for any one depth except that for which the opening is made.

In its most common form the divisor consists of a partition dividing the channel into two portions, in proportion to the respective claims. This, in effect, assumes that the velocity is uniform across the whole cross-section, which is not the case, even in a uniform channel, and much less so in one irregular or in poor repair. Such a division is to the disadvantage of the smaller consumer.

The nearer the velocity is uniform across the whole channel, the better this method of division, evidently. Accordingly means are frequently taken, by weir-boards or otherwise, with this object in view, but generally with indifferent success. A screen would accomplish this one object better, but the objections to its use are too many in most places to render it practicable.

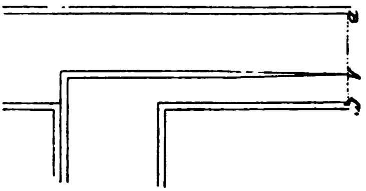

Fig .1.—A COMMON FORM OF DIVISOR.

Figure 1 represents one of the most common forms of divisors. The partition board A is movable, and may be placed at different distances from the side C, so that the user can vary the proportion of water which he receives. A cleat of some kind is often used to prevent the board from being moved beyond a certain limit. Where the ditch is wide and shallow there is sometimes a simple truss used, as in the Lariat ditch, in the San Luis Valley, with a depending cleat. Sometimes a wire or chain restricts the movement. In these cases it is usually assumed that the amount of water going to the side channel is in proportion to the distance the movable partition is from the side, and the ratio is the same to the distance across as the volume is to the volume in the whole ditch. This is not in general true, because the velocity across the cross-section is not uniform.

Sometimes where this is recognized, and it is necessary to make close division, the water is brought to a state of approximate rest, or to a state of approximately equal velocity throughout the channel. In the case of some divisors used on the Farmers' Union Ditch, in San Luis Valley, a weir-board over which the water drops, is placed above the division board. This secures an approximate equality. A fall below the point of division sufficient to prevent the backing up of the water is necessary.

If the water is brought to a complete state of rest, or very nearly so, and flows over the weir without lateral contraction, this method will give as satisfactory results as any divisor with which I am acquainted.

An increase in the size of the ditch just at the division box will aid in bringing the water to rest. Boxes of this kind were used by Hon. J. Max. Clark of Greeley, as early as 1867.

The divison which is in use at Elche, in Spain, is one which has developed from their conditions in that province. At Elche there is a peculiar system of water management. The water is owned independently of the land. The amount available is divided into a certain number of shares, and the use of each of these for twenty-four hours is sold each day in the market place to those who want water. In consequence the amount which enters any lateral varies from day to day, and the method of division requires a convenient way of varying the proportion.

Where the division is to be made. the sides and bottom of the canal are made of cut stone for a distance of about fifteen feet. There are two falls in the canal of twelve and sixteen inches respectively, about five feet apart, the upper one being about seven feet from the upper portion of the masonry. The canal for a distance of 150 or 200 feet above has little or no fall, so that the water reaches the first fall with almost no velocity, and passes over undisturbed and perfectly smooth. Furthermore, there is no contraction at the ends, so that the discharge is nearly in proportion to the length.

The arrangement for making the division consists of a partition which is permanent masonry, and divides the canal below the falls into two channels. At the upper end of this partition is a movable piece of wood coming to a point which is pivoted to the end of the partition, and can be held so that its upper end will include any assigned portion of the channel within certain limits. The length of the beak of wood is made so that it reaches to the upper drop when in line with the axis of the partition. The beak is set so as to include the desired portion of the channel and thus remains for twenty-four hours.

At Lorca, for a portion of the area under cultivation, there is a system of sale something like that at Elche, in which the amount which enters any ditch may vary from day to day. A divisor which may be called a needle divisor is used. The same care is used in the preparation of the channel as in the previous one described. A permanent masonry partition is placed in the channel. The proportion which enters the lateral channel is varied by varying the relative width of the main and lateral channels. This is done by inserting or taking out a series of narrow boards placed vertically. These are of uniform width. They are held in place both in top and bottom, and are carefully fitted to prevent leakage. The stream is to be divided so that a number of hilas, according to the result of the sale, may enter the channel. No account is taken of the difference introduced by contraction. The discharge is assumed to be proportional to the size of the opening. I have seen a divisor involving the same principal used on a ditch carrying seepage water, near Greeley. The form is not so good as the Elche divisor.

DISTRIBUTION BY TIME.

On small ditches or laterals where the amount of water is not too great for one user to manage, the time method of division may be used and gives a more equitable division than the boxes of the type described, and besides, it accomplishes what is necessary in order to use water economically, it allows the use of water in large enough quantities during irrigation to make the use much more economical than where used in minute quantities. If water is divided according to the various interests involved, so that each would receive constantly the amount to which he is entitled, and no more, it would often happen that the division would be into such small parts that little good would be done by the small stream of water thus furnished. It would thus become necessary in almost all localities to exchange water between neighboring users, so that one will use the privileges of several for the time duriug which he is irrigating, and then the others in like manner will use the water of their neighbor whom they have already accommodated. The time method of division carries this exchange of water to a greater extent and is especially applicable to the small ditches where the amount of water is small. In such case the exchange is systemized, and each one takes the whole stream of water for a time proportionate to his interests in the ditch, and the period is so arranged that the rotation will be completed in some definite time as a week or two weeks, or such other time as the experience of the locality has shown to be desirable for an irrigation to be repeated. The water will then be given out at night or day according to a schedule, and in order that the inconveniences may be fairly distributed, the period of rotation may be made with a fractional day, so that those who came in the night during the first rotation will come in the day during the second, and vice versa. Thus, suppose the period of rotation being taken as one week, or for reasons above given, 7½ days, and the number of shares be fifteen, of which some own one, others two, and some three shares. In this case each share would give its owner the right to use the water for one half day, or twelve hours; the owner of two shares would be entitled to its use for twenty-four hours, and the owner of three shares to thirty-six hours. Where there are a large number of rights or of users the same method would be carried out but to a greater extent. As carried out in the countries where it is applied, the division may be carried out until the exact number of minutes to which each is entitled to the water is determined. In such case a time table needs to be prepared in advance, usually at the beginning of the season Each one is furnished with a copy of it, as well as the ditch superintendent and employes, and the water is shut off or turned on the different gates according to schedule. The user must be ready to take it at the proper time or lose the water until his turn at the next rotation.

This method is best applicable evidently in the cases where the amount of water flowing into the lateral is constant. This, under the present conditions of American practice, is rarely the case. The water in the main ditch, and consequently in the smaller laterals, is subject to the fluctuations of the main stream. Where water is distributed from reservoirs, then the flow may be maintained uniform. The necessity for restriction in the use of water to certain assigned times is also distasteful to many. But by common consent, methods are used which are leading to the same system, and with the gradually increasing pressure for the greatest benefit from the amount of water available, there is little doubt that this method will gradually extend in use under the conditions where it is best adapted. With the varying streams and the varying flow, with the previously prepared time table, the method is not so equitable as the division of water as it comes. But with the advance of canal administration and with increase knowledge of the flow of water, it will be possible to adopt a modified time system of distribution which will be adapted to the varying streams. It is already in ditch administration in Colorado becoming customary to keep records of the amount of water which is taken into the canals. It will become increasingly desirable, and even necessary. For the large ditches taking water from the streams, the amount of water which is taken into the ditch for different depths of water in the ditch, is officially determined by the State Engineer or his deputies. A similar rating of the lateral ditches may be made, or weirs may be used with greater accuracy. As it becomes possible to find men who can use the various methods of measurement to determine the amount of water flowing, it will be possible to use a modified time distribution.

so that each will be given the water long enough to give each the same quantity. This would give a short time for the periods when the water is plentiful. and longer times when low. The unit could be varied, so as to bring the irrigations a convenient time apart. The successful operation of such a system would require an intelligent superintendent, and one who has the confidence of the users of the water, or a wide-spread knowledge among the users.

In the distribution of water from small reservoirs, where there are but few interested, and where the different owners do not care to use the water at the same time, some such arrangement is necessary. With the weir measurement it is possible to keep account of the amount used by each person, so that the water may be divided in proportion to the rights of each.

The devices for maintaining a constant flow may be divided into two classes:

1. Those which attempt to maintain the pressure of water above the opening constant, the orifice remaining unchanged.

2. Those which vary the size of the opening with different heads of water, in such manner as to keep the discharge constant.

Nearly all of the modules are of the first class, as the difficulties are simpler. The module of the Isabella Canal of Spain, described in the latter pages, and an excellent module, is of the second class.

But even if the head may be kept constant, the accuracy of the measure in those of the first class depends upon the kind of opening. The module proper consists of the orifice, the remainder being simply accessory.

The old Italian modules are mostly based on an orifice of a determinate size, the head above the orifice remaining constant. The miners' inch of the west and the statute inch of Colorado are such modules. Some of the Italian modules are circular, but most are rectangular of various dimensions. Those of the same kind had the same height of orifice and the same head. When different quantities of water were to be given, the orifice varied in length. But in all these cases it was assumed that the discharge was in proportion to the length of the opening. The prevailing form of measurement on the older canals of Colorado has essentially the same idea involved. It is generally attempted to deliver water through orifices of the same depths, but with variable widths according to the quantity of water to be furnished. But in cases where the elevation of the surface is such that the ordinary depth cannot be given, it is not uncommon to make the depth less but the width greater, keeping the area uniform. Among these Italian modules, the Milanese module, or sometimes called the Soldati module, has been the most celebrated, as it has been the best. This dates from 1585. The canals of the province of Milan had no good system of measure, though having been in operation for several centuries. There was much trouble and complaint. Finally the magistrates of Milan attempted to regulate matters, and called for plans of modules, and gave twelve conditions which a module should satisfy.

As the term "oncia" was given to the Italian unit, so the term inch has been used throughout this western country for the corresponding unit. The statutes of Colorado prescribe that water shall be measured through an orifice 6 inches in height, with a pressure of water of 5 inches above the opening, and that the number of inches shall be the same as the number of square inches in the orifice. But the term is not confined to the statute inch. On some ditches water is measured with a pressure of only two inches, on others without any, but the same term is used in all.

The only module of the second class is one which was first placed in operation on the Isabella I. canal of Spain, and is due to Senor Ribera. In this one the opening varies in size as the depth of water changes, being larger when the water is low, and smaller as the water is deeper. The method adopted is to allow the water to pass out through a horizontal opening in the bottom of the main canal or the head of a lateral. This hole is circular. Through this hole passes a plug of metal, which is smaller than the hole, the water passing between the plug and the outer circumference of the opening. By varying the diameter of the plug at different points, it may be so made that the opening will be reduced in such proportion as the head increases.

This module would seem to be satisfactory. There is little or no friction, but it has the disadvantage of requiring considerable loss of fall. If condition 11 is not important, the module doubtless will be very satisfactory.

For a discharge of 1.44 cubic feet per second, generally estimated in Colorado enough for 80 acres, with a hole twelve inches in diameter, the following would be the diameter of the plug for the given distances from the top of the plug:

Depth.	Diameter in Feet.
3 Inches	0.53
6 "	0.70
12 "	0.80
2 feet	0.87
4 "	0.91
9 "	0.94

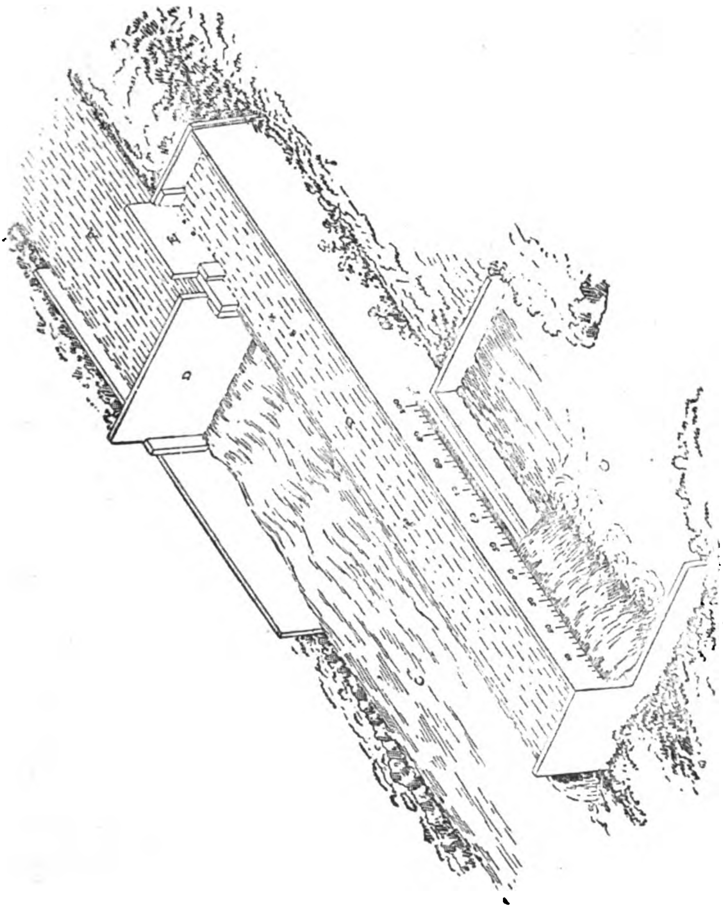

Figure 3.—SPILL BOX OR EXCESS WEIR.

Another means of preserving a constant head is due to A. D. Foote of Idaho, Past President of the American Society of Irrigation Engineers.

A cut of this was given in the *Engineering News* of November, 1886, and it has been more fully described in the transactions of the Am. Society of Civil Engineers, Vol. XVI.

In Fig. 3, A is the main ditch, with a gate forcing a portion of the water through box B. This has a board on the side toward the main ditch, with its upper edge at such a height as to give the required pressure at the orifice. Then if the water be forced through B, the amount in excess of this pressure will spill back into the ditch. If the box B is made long enough, and the spill-board be sharp edged nearly all the excess will spill back into the ditch, thus leaving a constant head at the orifice. Mr. Foote calls this the excess weir. To Mr. W. H. Graves of Monte Vista, is due the credit of its introduction into use on large canals, with the necessary modifications. He terms it the spill-box, a more suggestive name than that proposed by Mr. Foote. In use, Mr. Graves constructs a weir in the canal, and places the box at one side, always using two, if possible, one at each side, to save fall and expense. The spill-box is about 16 feet long, 14 inches wide, set perfectly level. The crest next the canal is brought to a sharp edge, and so are the 2x4 pieces on that side of the box. The gate for opening the orifice is of galvanized iron, worked by a rod and wing nut from the end of the box, so that it may be adjusted to any desired size of opening, and locked. The side of the opening is protected by strips of galvanized iron, with the double purpose of protecting the orifice from surreptitious enlargement and furnishing a groove for the gate to slide in. Mr. Foote thinks that the main ditch need not lose more than a few inches fall—enough to have the excess spill back. Mr. Graves prefers at least a foot.

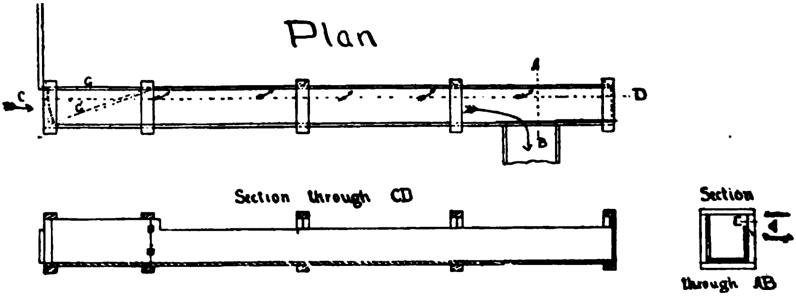

Figure 4--PLANS OF THE SPILL-BOX.

C is the entrance of water from the ditch; G a gate which serves to admit as much water as is desired; B the outlet furnishing water to the user. The small arrows show where the water spills back into the main ditch.

These have been introduced on the canals with which Mr. Graves was connected—the Monte Vista or Citizens' canal, the Rio Grande or Del Norte, the Grand River and the Montrose, which include the largest canals in the State, and it is now, 1891, being introduced on the North Poudre canal. The farmers whom I questioned in the San Luis Valley expressed themselves as perfectly satisfied with its fairness. The success of the device for maintaining the head constant is very

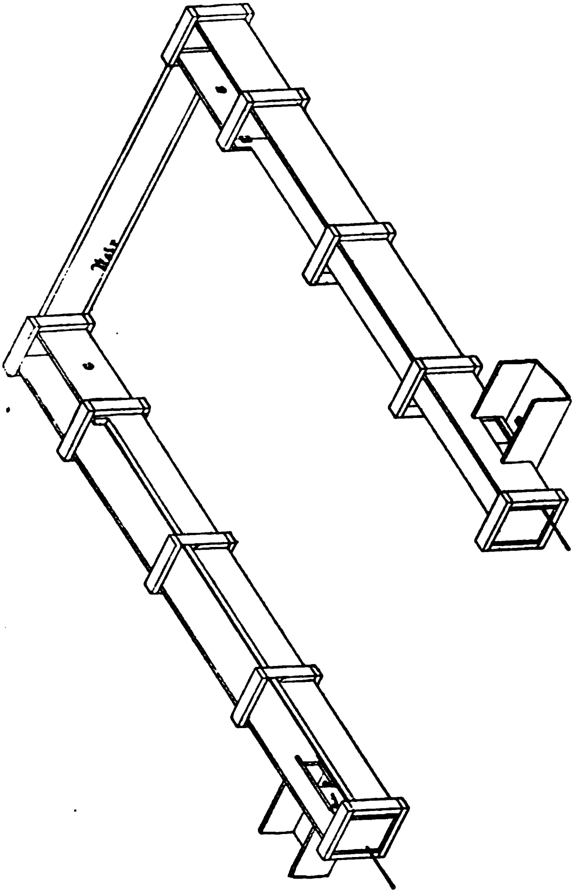

Figure 5—THE SPILL-BOX.
(As usually placed in pairs.)

The weir is placed across the ditch, making the ditch lower than above, giving opportunity for the water to spill back into the ditch. G is a moveable gate to regulate the amount of water admitted at different stages of water in the canal.

good, though it cannot be said to be perfect. It may be made much more sensitive. Under normal conditions the variations in head will be confined within small limits. As the spill-box is especially a device for keeping the head constant it may be used either with the weir or with the inch system, or with any form of opening. It would be very easily adapted to the Cippoletti form of weir. Unfortunately in its adoption by the companies with which Mr. Graves was connected the inch system of measurement was in use. With a single spill-box, when the opening is of different sizes, there will be caused a velocity of approach in the water which will tend still further to the favor of the larger opening. The effect of this may be lessened by making the width of the box greater for the greater discharges.

By making the box longer, so as to increase the length of the edge over which the water spills, the device may be made more sensitive. Mr. J. C. Ulrich, C. E., the successor of Mr. Graves as Chief Engineer of several of the large canals in the San Luis Valley, and of the North Poudre Canal, has in some places adopted on the latter canal a form where the box is placed so that it spills on both sides, and the sharp edge is made on both sides of the box.

THE WEIR MODULE.

But of all forms of modules, or that which best satisfies the first condition of accuracy, is the form of opening known as the weir, or overfall (French, *Deversoir*; Italian, *Stramazzo*; German, *Ueberfall*). It is not intrinsically more accurate than many other forms of openings, but as it is so simple that the conditions for accuracy may be readily met, and because there is a vast fund of experimental knowledge regarding its behavior under different conditions, no other form of opening can compare with it in accuracy.

Because of these facts and the growing importance of accuracy, the coming module will be based upon the weir. It is gradually displacing other types. Australia is using it, exclusively, we think; India, to to a large extent, and in Italy, the originator of most of our measures, the newer canals are using it to the exclusion of the Milanese module. The old canals will probably continue the use of the old module, for rights have become vested in measurement by them, and consumers are jealous of change. A large portion of the newer canals in Colorado provide that measurement shall be made over a weir. So far as learned no canal has abandoned its use. Cippoletti, who was commissioned by the Canal Villoresi to propose a new module in obedience to the requirements of the Italian government, says in regard to the weir:

"It is indisputably demonstrated that in weirs with complete contraction, constructed and observed with the necessary accuracy, *the coefficient of contraction remains constant*, and Francis' formula guarantees the exactness of the discharge with an error not greater than *one-half of one per cent.* for depths of water from 3 to 24 inches; providing the length of the weir is not less than three—or better yet, four—times the depth of water flowing over it." [Cippoletti, Canale Villoresi, Modulo, per la dispensa delle acqua, Milano, 1886, p. 135.]

Two forms will be considered, and tables given for their discharge—the rectangular weir, whose sides are vertical, which is the one ordinarily meant when weir is spoken of, and the one which has been the subject of experiment; and the trapezoidal weir proposed by Cippoletti, after a thorough investigation. Its sides are inclined at a slope of one-fourth horizontal to one vertical.

COST OF DAMS FOR STORAGE.

An important subject for consideration, in irrigation, is the use and cost of dams and reservoirs. The reservoir should be well built and at reasonable cost. The following figures on the cost of dams are taken from a letter written by Wm. Ham. Hall, and published by Hon. Francis G. Newlands in "An Address to the People of Nevada on Water Storage and Irrigation":

SAN FRANCISCO, August 22, 1890.

HON. FRANCIS G. NEWLANDS, Reno, Nevada:

My Dear Mr. Newlands—You have asked me to write something concerning the cost of canal works and of storing water, for your irrigation pamphlet to be put before the good people of Nevada, and I take pleasure in sending you this hastily-written letter, regretting that I am not enabled to lay before you, in detail, the full line of data on these subjects at my command.

Of course there are storage sites like Lake Tahoe, and similar natural lake basins which might be mentioned (the outlets being narrow and easily closed), where storage may be effected at exceedingly low rates; but these are hardly to be regarded as artificial reservoirs, even after dams are built.

In such places water may often be stored at less than a dollar per acre-foot of storage capacity. As you very well know from your own examinations, the cost of storage in Lake Tahoe will come to only a few cents per acre-foot.

At sites, however, such as are usually found, and such as must ordinarily be availed of, the cost of storage in California has ranged from two and a half to twenty dollars to the acre-foot, (this unit of measure being the quantity of water, which will cover one acre of land a foot deep). I will cite a few instances for your information.

The Boorman reservoir, the property of the North Bloomfield Mining Company, situated on one of the forks of the Yuba river, in Nevada county, holds about 22,000 acre-feet of water. It is closed by a rock dam of what is known as the hydraulic-mining type, of about 100 feet in extreme height, which backs water over about 500 acres of land, with a subsidiary waste-way dam, cost about $246,000—making the cost per acre-foot of storage something over eleven dollars.

This was regarded as a very favorable storage site, but not an exceptionally good one. Probably, at the present day, the dam might be built for about two-thirds of its original cost, reducing the cost of storage in that site to something between seven and eight dollars per acre-foot.

Eureka lake reservoir, another site within the water-shed of the Yuba river, constructed also for hydraulic mining purposes, occupies a natural lake basin. Here about 15,000 acre-feet of water were stored, at a cost of something less than two dollars and fifty cents per acre foot, with a rock dam whose greatest height is sixty-eight feet.

The Faucherie, a reservoir situated on one of the forks of the Yuba, another one of the hydraulic mining storage basins in Nevada county, also occupies a natural lake basin, wherein something less than 1,500 acre-feet of water have been stored at a cost of about six dollars the above unit of measure.

The English reservoir, still another of the famous hydraulic mining group, occupied a natural basin, which, however, had three outlets, and, consequently, required three dams. One of these was 131 feet high, the highest of its type (that is, the hydraulic-mining rock type) ever constructed in California.

The volume of storage in this basin was something less than 15,000 acre-feet, and the total cost of the works brought the cost per acre-foot to the neighborhood of eleven dollars.

Going to the southern part of California, Bear Valley, in San Bernardino county, presented one of the best sites for water storage which California holds. With a dam sixty feet in height, in the neighborhood of 30,600 acre-feet of water were stored. The cost of this construction was such as to make the rate per acre-foot about two dollars and a quarter. The work was far too light, however, and if a proper dam had been built there the cost would probably have been somewhere between three and four dollars per acre-foot. The company are building another dam to back up that now in place, so that the total cost of their storage (counting the two dams) will probably exceed five, if not six, dollars per acre-foot.

The Sweetwater reservoir site, in San Diego county, California, with a dam ninety feet in height, has a capacity of holding something over 18,000 acre-feet of water.

The dam here built is of masonry in cement and, consequently, a high-class work. Its cost was in the neighborhood of $234,000, or nearly thirteen dollars per acre-foot of storage commanded. Had this site been situated where, as in the case of irrigation reservoirs generally, it would not be necessary to construct such a high-class work, the storage within it might have been effected, in all probability, at an expense of eight or nine dollars per acre-foot.

The Crystal Springs reservoir, of the Spring Valley Water Company of San Francisco, is in one of the finest sites, not already a natural lake basin, known to exist anywhere. The dam which is now being constructed there is a high-class work of concrete. The estimated capacity of the reservoir space is over 90,000 acre-feet, and the expected cost of the work will bring the rate to the neighborhood of twenty dollars the acre-foot, or, probably, more.

If this reservoir site were somewhere in the Sierra Nevada mountains, commanding lands for irrigation, I am of the opinion that a suitable dam for that purpose could be built in its opening at a cost that would bring the storage effected down to eight or nine dollars the acre-foot.

The Cuyamaca reservoir, of the San Diego Flume Company, having an earthen dam forty feet high, cost for this work and outlet gates, something over $47,000. It has a capacity to hold between 11,000 and 12,000 acre-feet of water, which storage, consequently, cost at the rate of about four dollars and ten cents per acre foot.

The Hemet reservoir site, commanding lands of the San Jacinto valley, in San Diego county, has been surveyed and a careful estimate made for a stone dam at its opening—the expected cost being well over ten dollars to the acre-foot. This site will hold in the neighborhood of 18,500 acre-feet of water, with a dam 150 feet high.

A most wonderfully good site for the storage of water is found in

Kern county, where 146,000 acre-feet can be stored in one basin, at an estimated cost for a rock dam of about $152,500; or, at the rate of but little more than a dollar to the acre-foot.

And so at another point in the same county is found a site where 31,000 acre-feet can be stored, with a rock dam estimated to cost $84,000, or something like two dollars and seventy cents to the acre-foot.

I might go on and enumerate many other examples, but, to cut the matter short, and give you my opinion as briefly as possible, I will say that storage, with works suitable for irrigation enterprise, will commonly cost from three to seven dollars and a half to the acre-foot, where conditions are most favorable—with the exception of that class of sites which I first mentioned as natural lake basins, and a very few others.

By far the greater number of storage basins commonly thought to be favorable for impounding irrigation waters, however, when closely examined, are found to necessitate expenditures for dams, ranging from seven dollars and fifty cents to fifteen dollars to the acre-foot of storage capacity.

Of the sites within your Truckee and Carson basins, of which I have exact data, I expect from the surveys made for the benefit of your own people, you have already some definite knowledge. I may say, however, that aside from Lake Tahoe, Webber lake presents opportunity for the cheapest storage. There something over 11,000 acre-feet of water can be held at a cost between three and four dollars to the acre-foot.

Then, next in order comes Donner lake, where something over 40,000 acre-feet can be stored at a cost between five and six dollars per acre-foot. Or, by another scheme, not taking in all of the Donner and lower part of the Coldstream basin, about 22,000 acre-feet can be stored at a cost (according to the General Government Irrigation Surveys) of five to six dollars to the acre-foot. But judging from an inspection of the locality, and from private surveys, I think it likely that the cost in this case may not exceed four dollars the acre-foot.

Independence lake presents a fine storage site where 23,000 or 24,000 acre-feet of water can be stored for six dollars or seven dollars to the acre-foot.

Hope Valley, in the Carson water-shed, is a magnificient location, if we are to look to volume of water which may be held as the test, for there nearly 100,000 acre-feet of water might be confined, but the outlay would be at the rate of about nine dollars to the acre-foot.

Long Valley, at the head of Carson Valley, can be made to hold something less than 35,000 acre-feet, at a cost (estimated on the basis of the General Government Irrigation Survey) not to exceed five dollars and fifty cents for each acre-foot held, but the expense of this storage will be increased by the cost of delivering water to the site by means of a canal from one of the Carson. As in the case of Donner lake, it is likely that a closer examination and estimate may show that this cost need not be so great.

There are other sites of which I have some personal knowledge, where storage may be effected almost as cheaply as in those that I have mentioned within the Truckee and Carson basins. As, for instance, Sardine Valley and Henness Pass Valley. On the whole, I am of the opinion that conditions are exceptionally favorable for storage in the basin of the Truckee river.

I hope that better sites for storage may be found within the watershed of the Carson, and I have reason to believe that excellent sites exist within the basin of the Walker river.

Of the Humboldt I have no personal knowledge, but from a general idea of the character of the country, I do not doubt the existence of excellent storage basins there. The question in that case would be as to sufficiency of water available for storage.

The cost of irrigation canals in California and elsewhere, of which I have knowledge, ranges from two dollars to ten dollars to the acre which they are capable of irrigating.

Irrigation on the plains commanded by the Walker and Carson rivers, should not anywhere cost, for main canals with their principal branches. more than three dollars to the acre which they would be capable of serving.

In the basin of the Truckee this cost will be greater, I think, ranging between five dollars and six dollars to the acre—although, in the case of those lands which are already irrigated, doubtless their work can be duplicated at a less cost.

Supposing that your storage and canal combined works are to cost even as much as fifteen dollars per acre. Surely lands which are almost absolutely valueless without water, and which, being supplied with it are worth fifty dollars, can stand this outlay of fifteen dollars to effect the desired end.

Very truly yours,

WM. HAM. HALL.

METHODS PROPOSED.

As there is some difference of opinion relative to the best method for improving the arid lands, our farmers will be interested in reading some of the plans proposed. For this purpose we have made extracts from Bulletin No. 18, Wyoming Station.

The literature upon this subject presents four plans for securing the reclamation of the arid lands, which are now prominently before the country. Two of these plans provide for the exercise of jurisdiction and control over the work by the authorities of the national government; two provide for the exercise of such control by the authorities of the several States. The plans proposed for the prosecution of this work by the national government are: First, the building of ditches by direct appropriation from the Treasury of the United States, the work to be done according to plans provided by government engineers and under the supervision of government officers. The second of these plans provides for the work being done by private parties, who are given a lien upon the land to be reclaimed as security for the return of money invested in the construction of large canals; but the supervision of the work, the control of the lands, and the control of the water supplies to be under the supervision of the national government. The plans suggested for the prosecution of this work under State control are: First, the preparation of plans and the construction of works by State engineers, and the money to be provided by direct appropriation from the Treasury of the State by acts of legislation, or the sale of bonds which the State guarantees and protects by proper legislation. Second, the construction of ditches, canals, and reservoirs as private enterprises, but under plans prepared by the State engineer; the parties constructing the canals to be secured in their investment of capital by a lien on the lands reclaimed.

Another plan for carrying out this work has been suggested and discussed by the press of the country, viz.: That Congress should make absolute appropriations or donations for the construction of canals and reservoirs as it makes appropriations for the rivers and harbors. But such a plan has never been advocated in Congress. Many of the best lawyers of the country hold that Congress would have no constitutional right to make such appropriation, and a plan of this nature would no doubt meet with unanimous opposition from other sections of the country.

Another solution proposed for the difficulty is to let the lands remain in the hands of the national government, to be administered through our Interior Department under amended Federal Land Laws, which meet the conditions of the arid region, and which are based upon the fundamental principles previously stated, the work of the reclamation of the arid lands to be carried forward by an act of Congress by which the proceeds arising from the sale of public lands in the arid regions should be given to the respective States for internal improvements, to be expended and controlled by the authorities of each State. Besides the building of roads and bridges out of this fund, the large amount realized by the State could be expended in the construction of large canals and reservoirs, which the respective States would own and control as they do the water in the natural streams. This would give to each State a fund out of its own resources to begin the work of reclaiming large bodies of land, the actual farmer and settler to be allowed to attach their laterals to these large canals and reservoirs without expense, and under priority of right to secure the amount of water necessary to irrigate the amount of land which they could successfully cultivate.

The method which has provoked the most discussion and perhaps the greatest popular interest is the ceding of the arid lands to the respective States, so that each State may work out its own destiny under State legislation in dealing with this domestic question (for such it seems to be with all the arid States). This matter has been brought prominently before the people of the United States by the Warren Arid Land Bill, which proposes to cede all the arid lands to the respective States; and by the Carey Land Bill, which proposes to cede to the States a limited number of acres under conditions which provide for the State's reclamation of the land ceded to the respective States; both of these bills being based upon the fact that reclamation of arid lands is a domestic question which should be relegated to the States interested in this problem.

Mr Joseph Nimmo, Jr., a special agent of the Department of Agriculture, after making a trip in the study of this question, through Montana, Washington, Idaho, Wyoming and Colorado, reports a decided sentiment in favor of ceding the arid lands to the several States. Mr. Nimmo states that the reasons advanced for the irrigation and ceding of lands of the arid regions are set forth quite fully in memorials to Congress adopted by the Legislatures of Wyoming and Idaho. The ground upon which these memorials and the public sentiment appear to rest are as follows:

"(1) The proposition that the irrigable and pastoral lands of the Arid Region should be donated to the States has abundant precedent in the donation of swamp lands to the States, and also of lands for schools, seminaries and agricultural colleges, and for public improvements. These donations of lands have been about as follows:

	Acres.
Swamp lands	80,200 000
Lands for school, seminaries and colleges	78,800,000
Lands for public improvement	7,800,000
Total	166,800 000

"The total area of irrigable land in the Arid Region is estimated at about fifty million acres. Previous estimates which made it over one hundred million acres are now regarded as erroneous. No estimate has been made as to the area of pastoral lands, which are in the aggregate of much less value than the arable lands will be when irrigated.

"(2) By the terms of the charters of the several Rocky Mountain States, the waters thereof are the property of the State. This was first expressed in the constitution of Colorado, as follows: 'The water of every natural stream not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and is dedicated to the use of the people of the State.' This is in the nature of an irreversible compact.

" (3) Besides the compact just referred to, the Supreme Court of the United States has declared the right of the States to control the distribution and ownership of water, and Congress has by statutory enactment also recognized this right. (U. S. Rev. Stat. 2339 and 2340). Just here it is proper to observe that throughout the Arid Region values inhere in the water and not in the land.

"(4) The administrative features of the law of appropriation for beneficial uses are peculiar, differing necessarily in the different States, and in different parts of the same State Privileges which would be applicable to certain streams and in certain localities are not applicable to other streams and in other localities. The enactment of laws which shall meet all these exigencies requires personal and experimental knowledge of the subject of irrigation.

"(5) The administration of the law of appropriation for beneficial uses involves the determination of such questions as the following:

"(*a*) Questions as to priority of appropriation.

"(*b*) Questions as to preferences which shall be granted to the use of water for domestic uses, for agricultural uses, and for manufacturing uses, and generally touching the practical application of a doctrine of law upon this particular subject.

"(*c*) Questions as to the limits which must be placed upon the total area of lands which the waters of particular streams are sufficient to irrigate, and which such waters can be permitted to serve.

"(*d*) Questions as to the economic and proper use of water.

"(6) Congress will always be composed of Senators and Representatives familiar with the law of riparian rights, but unfamiliar with the law of appropriation for beneficial uses. This latter law must necessarily prevail in the Arid Region, with all the consequents of that law, vitally affecting the material interests of the people.

"(7) The people of the Arid Region believe that for reasons above stated, Congress will never be able to legislate wisely, or beneficially in regard to the interests of the people.

"(8) To the objection that the power of disposing of the public lands, if conferred upon the States, might be a source of corruption, and an instrument of partisan struggle in the several States, the reply is made that the whole subject will always be open to a general public scrutiny which will operate as a barrier against such prostitution of the power conferred.

"(9) While the United States government retains the ownership of the lands, and disposes of them under the provisions of laws not at all in harmony with the principles which govern development by means of irrigation, there must necessarily arise conflicts between the administration of State and National laws.

"(10) The cost of irrigating works must be realized out of the profits arising from the improvement of the land reclaimed. This is evidently the natural and proper mode of development. In this way the largest results in irrigation have already been achieved. The land laws of the United States not only prevent this, but worse still, so operate as not only to enable but to incite individual land claimants to thwart the plans of companies which are inclined to enter upon large schemes of development, and to reclaim lands which cannot be reached by private enterprise.

"(11) The memorials of the States of Wyoming and Idaho declare that the progress of those States has been greatly retarded by the fact that corporate capital has not been enabled to engage in the work of building the larger irrigating works, designed to reclaim lands which cannot be reached by individual enterprise.

"The memorial of the State of Wyoming states that if the late Territory of Wyoming could, during the past five years, have controlled the disposal of the irrigable lands within its borders, it could, while disposing of it to actual settlers only, have afforded such protection to canal companies as would have given our agriculture four times its present importance and more than doubled our population.

"The memorial of the State of Idaho embodies this precise language, except that it says *ten years* where the Wyoming memorial says *five years*.

"(12) The subject of irrigation is evidently not one which, like the rainfall, can be left to the operation of natural forces, even after the reservoirs and natural ditches are constructed; but it is one which all experience proves must be made the subject of constant governmental supervision and control. Wherever irrigation is practiced, such supervision and control is regarded as a public function. This inheres in the fundamental doctrine of law regarding the subject of irrigation, viz., that the water transported is the property of the public, and that the State must administer the distribution of the public supply.

"(13) It appears to be clear from the foregoing that the regulation of the water supplies of an irrigated district has no analogy in transportation affairs, nor in the ordinary commercial and industrial operations, but must be classed with those industries which, like the coinage of money, the carriage of the mails, public instruction, etc., are from the dictates of experience and of reason regarded as absolutely or in certain particulars public functions.

"(14) During the last seventy years the national government has simply acted as the agent and trustee of the people regarding the sale of public lands, without treating them as a source of national revenue. This is a settled feature of our national policy. It is believed that this agency and trusteeship can now be safely transferred to the States of the Arid Region."

It would seem that this whole problem must be kept in the hands of the people, and worked out under wholesome National and State legislation which shall protect and encourage capital, as well as secure lands for the use of the actual settler, who will be induced to come to the arid States because of the success which awaits them through reclaimed lands under the security of wise and equitable laws.

CONCLUSIONS OF THE BRITISH COMMISSION.

On December 23d, 1884, the British government appointed a royal commision on water supplies and irrigation. It was the duty of this commission to investigate the subject ot irrigation in Egypt, Italy, India and the United States, with a view ot compiling this information for the guidance of legislation on the subject of irrigation for the province of Victoria. This commission made a special study of irrigation laws; water rights, and methods of constructing large irrigation works in the various countries visited. They have made various progress reports from time to time which have been printed by the British government in Australia. These reports contain much valuable information, and have led to the adoption of the system now practiced in Victoria, which is regarded as combining the wisdom and best methods on irrigation that can be culled from the practice of the world.

On the subject of irrigation in Italy, the British Commission makes the following statement:

"In the first place, it is important to note that almost all the irrigation canals in Piedmont and Lombardy now belong to the State, and the fact is all the more striking when it is remembered that a majority of them were originally constructed by private enterprise. The reason for this change of ownership is not difficult of discovery. As Baird Smith notes, the dangers arising out of monopoly of water, apart from the ownership of the soil, have commended their purchase to the statesman. Both processes, starting out on different principles, have arrived at the same conclusion. The Lombard practice of never separating the water from the land has palpably produced most beneficial results, and, in his judgment, was the chief cause of the rapid multiplication of secondary canals constructed by the private enterprise in that province.

"In Piedmont, the State's proprietary of the water has been almost equally efficacious in encouraging its equitable distribution; but its ownership of the headworks has come to be recognized in each as the best means of insuring justice to the irrigator."

The Commission further states that "Italian experience, French experience and Spanish experience all go to show that the interests to be studied in relation to irrigation schemes are so many and so various and so intimately bound up with the public welfare that State control is imperatively necessary, and that for the protection of its citizens no monopoly can be permitted which would separate property in water from property in land to which it is to be applied. But at the same time it is established that while a general central control by the State is essential, the business management and distribution of the water is much better placed under the local authority, as this is more effective in its supervision, more economical in its administration, and is educational, also, in a political sense, to a high degree. The establishment of a comprehensive system of irrigation by private enterprise is possible only under unusual conditions. If it embraces many sources of supply, large areas, or conflicting interests, it is impossible. The capital required is large, the returns are not rapid, and the full benefits secured by the close occupation and complete utilization of consideraable areas are so reduced that the State could reach those benefits in unnumbered ways, and settlers are not justified in assuming large responsibilities in their initiation. This becomes palpable when it is perceived that as in Egypt and Italy, carefully matured schemes insure an enormous agricultural production, and the stable prosperity of a large number of producers. It may be safely asserted from foreign experience of many generations that irrigation is one of the soundest national investments, where engineering ability and executive work are expended upon large canals, which are afterward taken under local control, guided by a carefully compiled code of water laws and regulations, while the land whose production is enhanced is charged with the interest upon the capital expended in supplying it. All of these conditions we ought to possess in Victoria."

In conclusion, the Commission makes the following important statement:

"Over and above all differences, and apart from all advantage and disadvantage, there are certain special lessons to be learned, even from a cursory glance at the field of knowledge bearing upon irrigation in Egypt and Italy. In both, the supreme control of the water is vested in the State, and in both the most important works are undertaken by the State, or under its supervision. In both it is demonstrated that no lesser authority can be entrusted with so vital an element of national production. But on the other hand it is found in each country that the State is incapable of satisfactorily discharging the administrative task of distributing the water to individuals, or undertaking its delivery at convenient times, of supervising its measurement, or the canals by which it is conveyed, or to collect its dues in an inexpensive manner.

"In Egypt the village commune; in France and Spain the association, and in Italy the syndicate, intervene between the State, which owns the water, and the individual who purchases it while in the first directly and the last indirectly the State has its advances secured upon the land which is watered. This system is unknown in America; for though State ownership of water is secured in the constitutions of Colorado and Wyoming, there are colonies in California which partake of the communal principle, although the two are not conjoined. There are no State works, but virtually those private persons who construct them do so upon the security of the lands benefitted. The best American opinion, however, is in favor of such a system of divided responsibility between the settlers and local government, and it has been envied and admired by eminent Indian authorities as well. We are therefore able to claim that the policy adopted in Victoria is in accord with the judgment of those most competent to form an opinion in Europe, Asia and America.

The investigations of this British commission led to the adoption of what might be called the "communal" principle for reclaiming the arid lands of Victoria. Water trusts are formed somewhat similar to the Irrigation District in California under the Wright Act; but these Water Trusts by law are under governmental control, and can only be carried forward by the sanction of the government, which passes upon the feasibility of the scheme, and also the available water supply for the uses of the proposed Water Trust. The irrigation act of 1886 in Victoria declares the water of all streams to be the property of the Crown, provides for the extinction of any riparian rights that might prevent the use of water for irrigation, authorizes the construction of national works by the State, and enables Trusts directly elected to carry out their schemes with the money advanced from the public treasury. The success of this method of reclaiming the lands in Victoria is shown by the following statement:

"When it is recollected that the first trusts in the colony were not formed until 1882, and the first Irrigation Trust not until 1884, 'the progress that has been made may be estimated in a general way from the fact that there are now twenty-four 'Water Trusts,' covering an area of 6,300,000 acres, and six Irrigation Trusts, covering an area of 356,788 acres, in addition to fifteen applications for the constitution of new Irrigation Trusts which will cover nearly 2,000,000 acres more."

This commission, out of the various facts gathered by investigation, have enunciated several very important principles which have been applied in the solution of the problem of irrigation in Victoria, which are as follows:

"*First.* In any distribution of water under the authority of the State, owners of the land must be deemed to have a preferential claim on the sources of supply for enough to meet any reasonable domestic requirement and for the watering of stock up to the full carrying capacity of their pastures.

"*Second.* It is necessary, therefore, that before authority be granted to carry out schemes, and the requisite funds advanced, the government be well assured the proposals are sound, both from an engineering and financial point of view. It is also essential that they should be satisfied that the body of rate-payers on the area on which the cost of the work will fall are agreed as to its necessity, and that the proposed expenditures thereon will be judicious, and the benefits a fair equivalent for the annual charge entailed."

It would seem from the above facts and conclusions of the British Commission that they had adopted the Irrigation District principle now in vogue in California under what is known as the "Wright Act;" that the communal principle and the irrigation principle are similar, except that in Victoria the government oversight of the Irrigation Trust is so strong and vigilant as to prevent abuses and failures, which have sprung up, in some instances, under the Irrigation District system of California.

So far as we have proceeded in this matter as a State, we have made no mistake in our legislation. We have observed the fundamental principles which underlie the problem, and are now the admiration of the students of the problem of irrigation in the West. In the State's control of the water with its system of administration, we find that under the laws of 1890-91 provision is made for the formation of Water Divisions for administrative purposes. The Superintendent of each Water Division, who is appointed by the Governor, by and with the consent of the Senate, together with the State Engineer, make up our State Board of Water Control, whose duties are clearly outlined by law. Now it would be an easy step, in harmony with present irrigation laws, to make provision for the creation of Irrigation Districts upon the communal principal of Victoria, with municipal or quasi-municipal powers for the sole purpose of reclaiming land. These Irrigation Districts would vary in size according to locality and the amount of land to be reclaimed from and under the same system of ditches. Our present system of water control would still stand as an excellent method of State control and administration of our water supply, by which all parties would be protected in their priority of water rights, and in the adjudication of disputed claims.

Summed up in a few words, the Irrigation District, under the statutes of California of 1887, is a municipal corporation, having the same powers to construct irrigation works and to furnish all lands within it water for irrigation, that are possessed by a city or incorporated town to construct water works and to furnish water for its inhabitants for all domestic purposes. These powers are familiar to all and are readily understood.

QUESTIONS ON IRRIGATION.

The following questions were forwarded to farmers and county officers, but to date only two have returned answers. Mr. Geo. Alt of Reno and one of our leading farmers of Carson Valley·

1. What kind of soil have you?

2. Do you have any difficulty in excavating for the larger ditches?

3. What grade, to the mile, are your large ditches?

4. What is water worth an inch for the season?

5. Do you flood or furrow in irrigating grain and alfalfa?

6. How many irrigations per season for grain?

7. " " " " " " alfalfa?

8. " " " " " " corn?

9. " " " " " " orchard?

10. What crops have you raised without irrigation?

11. What kind of "checks," or dams, do you use in the field away from your principal ditch—earth, canvas or small boxes?

12. Do you use irrigation to get grain up?

13. Do you ever irrigate grain lands before plowing—working as soon as sufficiently dry?

14. At what stage of ripening do you irrigate grain the last time?

15. How many acres of grain, using 100 inches of water—all conditions being favorable—will an experienced man irrigate in 24 hours?

16. Will you give approximate figures for largest ditch in your section—date built, length, width, depth, cost per mile?

17. Size and cost of reservoirs in your section?

18. What form of box and how much pressure do you use for measuring water?

19. Do farmers of Nevada need an officer, known as State Irrigation Engineer, who shall do surveying, affecting State interests and adjust water disputes?

20. Do irrigation interests require special legislation at the next session?

21. Will you make any suggestions that you consider would be of advantage to the irrigation interests?

(*Qaestions sent out by the Nevada State Commission of the National Irrigation Congress, to obtain the views of citizens before reporting to the National Congress:*)

22. What, in your judgment, is the maximum amount of public land which a settler should be allowed to take up under systems of irrigation?

23. Do you favor the transfer of the arid public lands and the control of the reclamation to the State; or the construction and management of irrigation works by the General Government?

24. If the transfer to the State, what conditions should govern such transfer?

25. What method for management or disposal of the grazing lands would you suggest?

26. Do you favor the doctrine of public ownership of waters, subject to appropriation for beneficial purposes, under supervision of governmental authority?

27. Do you favor the division of the water among appropriators by officers of the government or by local officers?

28. Do you favor the control and division of waters of inter-State streams under National authority, or would you leave the matter to the respective States?

The following questions on irrigation and remarks were returned by one of our citizens who has given years of study to irrigation on the Coast:

16. The Orr ditch is the largest taking water from the Truckee river. Its capacity is seventy five cubic feet per second. Width and depth not uniform. Total length, including extensions, nearly twenty miles. Cost not known. With two exceptions, this is the largest irrigating ditch I know of in the State. These exceptions are on the Humboldt river in Humboldt and Eureka counties.

19. A State engineer is very much needed, and the necessity of such an officer is constantly growing. Many of the streams of

the State are over appropriated, and as a consequence, disputes and litigation are increasing. At present we have no knowledge of the volume of water afforded by our streams, nor the amount appropriated: neither have we any official knowledge of the amount of land under irrigation. Such knowledge would be of great value to the State at large and of especial value to those now owning water rights, as tending to prevent disputes in the future, stopping over-appropriation—if the necessary legislation be provided—and through the office of State Engineer is the only proper channel to accomplish this. Such an office as this, heading a special board, such as exists in the State of Wyoming, would also furnish, what appears to me, the best and most rational means of adjusting any disputes that might arise, as well as providing the means for preventing such in the future. Further, if the State proposes to avail itself of the grant recently made under the Carey Law, passed at the last session of Congress, such an office becomes an absolute necessity.

20. Irrigation interests do require special legislation at the coming session of our Legislature. At present we have absolutely no irrigation law on our statute books. There is no law in Nevada prescribing a method of procedure to acquire title to water. Some law should be enacted prescribing this, and placing titles to use of water as near as may be on the same plane as titles to land. Also a unit of measurement should be fixed by statute.

I enclose a paper, the preparation of which called for some thought, and embodies some conclusions arrived at after a good many years of study and experience.

Referring to the questions sent out by the Nevada State Inv. Commission, I will say that out of some hundreds only about 60 or 80 sets of answers were received, and the great majority answered somewhat as follows:

22. One hundred and sixty acres.

23. To the States.

24. That such transferred lands should only be disposed of to *actual settlers* in tracts not exceeding 160 acres to the settler, and before title issue to such settler he be required to improve same and establish a bonifide house thereon.

25. Answers very meager and unsatisfactory, and I do not feel qualified to answer.

26. Yes, under *State* supervision.

27. By local officers.

28. Leave it to the States.

ANSWERS TO QUESTIONS BY MR. ALT.

1. From a poor quality of clay-alkali soil to the best quality of sandy loam.

2. No.

3. Ten feet.

4. I do not think a farmer can afford to pay more than $1.50.

5. Furrow.

6. Three.

7. Three.

8. Four.

9. None.

10. All crops that grow in this latitude.

11. Earth.

12. Better to sow early and get up without irrigation.

13. Always.

14. In the milk stage.

15. Twenty-five acres.

16. Pioneer Ditch; four miles long, six feet on bottom, two and one-half feet deep, cost about $250 per mile; built in 1861.

17. None.

18. We measure from a four-inch box. We approximate from the velocity of the water per cubic foot per second.

19. Yes.

20. Yes. The entire control of water should be taken out of the hands of our Courts and vested in a Board of Commissioners composed of practical farmers; all water trials should be heard by that Board at a nominal expense, and the foolish laws we now have should be thrown aside.

21. Yes.

(*Questions sent out by the Nevada State Commission, to obtain the views of citizens, before reporting to the National Irrigation Congress:*)

22. Eighty acres.

23. By the General Government.

24. A separate commission.

25. Leave the management as it is. Let the public have the benefit of them.
26. No.
27. Local officers.
28. Leave the matter to respective States.

(*Remarks by Mr. Alt.*)

Water should be divided by a Board of Commissioners in accordance by prior appropriation, and when the prior appropriator does not need the water it should be used by those needing it. The water should be controlled and measured out under the direction of a Board of Commissioners. We have no water laws at all here. The water is taken out of the river without consulting any one else's interest. The last ditches out of the river in time of scarcity of water, by being located the farthest up the river, take all the water, and the prior appropriator goes without. We had a good law passed four years ago, but has since been repealed. The only thing the people were afraid of was the determining of the rights by our Courts. If there had been a Commissioner to determine our rights, instead of the Courts, the law would have been popular. The trial could have been had by a Commissioner at a nominal expense, but by our Courts—the machinery of our Courts is too expensive. A Commissioner could go from ditch to ditch on any river with but little expense. A few witnesses could be called to establish the prior right of the ditch.

Yours, etc.,

GEO. ALT

ANSWERS FROM CARSON VALLEY

1. Mostly sandy loam; some adobe.
2. Ditches are easy of excavation.
5. Furrow altogether.
6. Four or five.
7. Three or four.
9. Two or three.
11. Wooden boxes.
12. Yes, but it is bad policy.
13. At times, and on some soils.
14. As it is in the last stage of milk
15. Twenty-five acres.

17. Small.
18. None in use.
19. No.
20. I think not.
21. One.
22. Eighty acres.
26. Yes.
28. To the nation.

GRAIN WITHOUT IRRIGATION.

For three seasons small plats of grain, oats and wheat have been raised without irrigation. The wheat varieties used were Gypsum and Ruby—oats, Highbred and Excelsior.

Quite full notes have been taken on these grains during the growing season, but for the present writing a brief summary will be presented. The general rule, in this State, is to use irrigation to raise crops. The number of irrigations per season varies from seven to ten in the valley about Reno, and from two to three irrigations at Lovelocks, 90 miles east.

It was only by trial that we could gain any idea of what could or could not be done without irrigation. The ground used for this trial is situated near the west entrance, is largely sand, with some gravel, and a small amount of clay. The plats have received one medium coating of manure in three years. With an average rainfall of about seven inches, and almost constant sunshine during the growing season, the trial on grain without irrigation is severe. This experiment, while yielding very moderate financial returns, carries with it an emphatic suggestion, that from one to three irrigations in seasons of great shortage of water, would produce more than enough grain from a few acres to supply the bread and seed necessary for a family, items that have, at times in the history of the States, been conspicuous by their absence. In our experiments for '93 and '94, one, two and three irrigations produced respectively 669 pounds, 776 pounds and 1,837 pounds per acre. The first two yields, as previously explained, were from ground that was drilled without fitting or manure, the third, from ground that was well prepared and heavily manured. All plats for the season of '93 gave the best growth.

Gypsum had the appearance of grain that had received at least one irrigation, due to the thorough soaking the ground received from continual and unusual rains during the winter of '92 and '93.

In 1892 scattered and irregular shaped patches, in all of the plats, failed to head. These were measured and estimated, but at the best, with any reasonable outlay of time, could only result in approximate measurement, so it was decided to omit yields for this year. In length of head and straw there was a marked difference, even with samples separated by only a few feet.

Much of the best growth was found in the outside rows, as it is in plats of grain raised with irrigation.

SUMMARY. NO IRRIGATION.

1. Use water moderately when obtainable.
2. When water is short, or none to be had, sow early on well prepared land. Sow the best seed—45 to 60 pounds to the acre—seed that has been cleaned and screened.

Grain Without Irrigation.

For '92, '93 and '94.

WHEAT.

DATE.	RUBY.	GYPSUM.
1892. Drilled Feb. 20.	Length of straw, 23 to 26 in. Length of head, 1½, 2, 4 in. Date ripe, 7 18.	Length of straw, 26 to 28 in. Length of head, 3 to 4 in. Date ripe, 7-18.
1893. Drilled March 16.	Length of straw, 15 to 25 in. Length of head—best—3 in. Date ripe, 7-22. Yield, rate per Acre. } 722 lbs. 8 ozs.	Length of straw, 11, 25, 32 in. Length of head, 1½, 3, 4 in. Date ripe, 7-21. Yield, rate per Acre. } 730 lbs.
1894. Drilled March 15.	Length of straw, 12, 22, 28 in. Length of heads, 2, 3½, 4 in. Date ripe, 7-24. Yield, rate per Acre. { 75 lbs. seed per acre, 108 lbs. 40 lbs. seed per acre, 250 lbs. }	Length of straw, 17, 22, 27 in. Length of head, 2½, 3, 3¾ in. Date ripe, 7-24 Yield, rate per Acre } 246 lbs.

OATS.

DATE.	HIGHBRED.	EXCELSIOR.
1892. Drilled Feb 20.	Length of straw, 11 to 30 in. Length of head, 7½ in. Date ripe, 7-19	Length of straw. 16 to 25 in Length of head. 6 to 15 in. Date ripe, 7-19
1893. Drilled March 16.	Length of straw, 13, 29, 35 in. Length of head. best 5, 10½ in. Date ripe, 7 17. Yield, rate per Acre. 115 lbs.	Length of straw, 12, 24, 29 in. Length of head, best 5½, 7½ in Date ripe, 7 19 Yield, rate per Acre. 110 lbs.
1894. Drilled March 15.	Length of straw............ Length of head.............. Date ripe.................... Yield, rate per Acre.	Short—6 to 12 in. Medium—12 to 20 in. Best—28 to 30 in. Length of head. 11 in. Date ripe, 7 24. Yeild, rate per Acre, 1. 16 lbs. 8 ozs per A. 2 15 lbs per acre.

In column headded Excelsior, under yield, 1 gives yield of oats raised from seed that grew without irrigation; 2—yield from seed that grew with irrigation. Highbred oats were omitted in the '94 trial.

SUMMARY.

1. Try arbitration for the settlement of water questions under dispute.

2. Irrigate in time but not too often.

3. Don't rely too much on water to raise crops. In connection with it use crop rotation, manure, plow under alfalfa or clover—practice thorough and timely cultivation.

4. Have as little waste water as possible. Use the waste, when practicable, from one plat or field on an adjoining field.

5. It is quite easy to run water on ground too long at one point. This is sometimes necessary in order to irrigate well a certain portion of the field.

6. The reservoir is the savings bank which should receive the surplus water, on the same basis that surplus funds are placed in the bank to bridge over a dull season.

7. In the fall or winter where there is less call for water and help is plenty, ground may be well irrigated and in all probability will need less water the following season.

8. In small area, this season, we have irrigated ground—allowed it to dry sufficiently to work—then sowed grain which came up at once, making a good stand.

9. Watch streams on hillsides to prevent the cutting of gulleys that are difficult to fill or work over.

10. Invest moderately in sub-irrigation, steam or windmills, till practical experience says the outlay will be justified.

FEEDING STUFFS.

NEVADA STATE UNIVERSITY.

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Agricultural Experiment Station.

BULLETIN NO. 26.

RENO, NEVADA, DECEMBER, 1894.

Agricultural Experiment Station

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Address all communications to

THE DIRECTOR,
Agricultural Experiment Station,
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FEEDING STUFFS.

NATHANIEL E. WILSON. FREDERICK STADTMULLER.

The feeding stuffs raised in Nevada have received little attention from a chemical standpoint, consequently little is known of their composition. While, in general, the composition of the common forage plants is about the same as that of those grown in other parts of the country, it must vary somewhat on account of the peculiar local conditions existing in this arid region.

The object of this bulletin is to give general information upon the subject of cattle foods to such persons of the State as may be interested, and is preliminary, the Station having under way an exhaustive examination of the various food plants grown in this State, a full account of which will appear in another bulletin. In that work especial attention will be given to Alfalfa (lucerne), upon which very little work has been done in this country, aside from that done by Dr. David O'Brine at the Colorado Station in 1889.

The few analysis of Nevada grown food plants that have been made are herein presented, viz: Five samples of alfalfa, four samples of corn fodder, one sample each of Polish wheat and buckwheat, six samples of sugar beets, and three samples of beet leaves.

TERMS USED IN THE ANALYSIS OF FEEDING STUFFS.

In speaking of feeding stuffs, used for the nutrition of farm animals, there are employed certain technical terms, which while conveying to a person familiar with them, a complete understanding of the chemical composition of a food; to those not familiar with their use, they are wholly unintelligible. In order to render a full understanding of these terms possible, a brief explanation of them is here given:

All fodders are made up of two parts, viz: *Water and dry matter.*

Water is found in all feeding stuffs and is by far the most abundant constituent of green and succulent fodders.

In 100 pounds of alfalfa (green) there are about 62 pounds of water, and in beets, turnips, etc., as much as much as 90 pounds in every 100 pounds. In hay straw and the various grains we find the average amount of water to be only 10 to 15 per cent.

Dry matter is that part of fodder left after the water has all been driven off. It is composed of two parts: (1) mineral matter or ash, the part left on ignition and which is principally the bone forming material of the fodder; (2) organic matter, which is the part of the fodder destroyed by ignition. It is composed of the following group of nutritive substances: (a) fat: (b) crude protein; (c) crude fiber; (d) nitrogen free extract.

The fat or ether extract includes whatever is dissolved out of the fodder by dry ether, from the water free substance. Of this extracted matter, fat usually constitutes the larger proportion, the remaining matter consisting of chlorophyl (the green coloring matter of plants) resins, plant wax and various other substances. The term ether extract is a much better name than fat, as it includes all of the extracted matter.

Crude protien signifies a large number of bodies all characterized by the fact that they all contain the element nitrogen which none of the other components of organic matter contain. Crude protein includes albuminoids and amides. The albuminoids are the substances which go to make up the flesh ligaments, tendons, etc., of the animal body, and are often called the "flesh formers." The most common type of albuminoids with which we meet are lean meat, white of egg, curd of milk and gluten. Albuminoids are either insolluble in water or if solluble are coagulated by heats, acids, ferments, etc. In this respect they differ from amides, which are all solluble in water.

The nutrive value of amides is somewhat lower than that of albuminoides, but their value has never been fully determined, it being but recently that a study of their functions had been undertaken. Amides are found in considerable quantities in immature plants and root crops.

The albuminoids contain on an average about 16 per cent. of nitrogen. In chemical analyses total nitrogen and albuminoid nitrogen are determined; the total nitrogen multiplied by 6.25 $(= \frac{100}{16})$ equals crude protein, and albuminoid nitrogen multiplied by 6.25 equals albuminoids; the difference gives amides.

The protein bodies are of the greatest importance for the nutrition of animals. They supply the material for building up the tissues of the body and for maintaining these under the wear incident to performing their vital functions. If present in excess they may be used for fat formation or heat production of the animal body. This may be accomplished by the nitrogen free nutritive elements, such as starch, sugar, cellulose less expensively, hence it is not rational feeding to use an excess of portein.

Crude fiber or cellulose is the framework of plants, forming the walls of their cells. Usually it is the least digestible portion of plants. It is determined, in the laboratory, by dissolving out all parts of the fodder by means of boiling out in weak acid and alkali solutions successively.

Nitrogen free extract is that portion of the organic matter left after deducting the ether extract, protein and crude fiber. It contains starch, sugar, gums, pentosans, organic acids and other bodies. Together with cellulose it forms the group of bodies called carbohydrates, all of which contain the three elements—carbon, oxygen and hydrogen.

Carbohydrates are the heat producers, and also assist in the formation of fat, and supply energy for the production of work.

A very clear explanation of the functions of the above substances is published in an annual report of the Connecticut Station, from which we take the following: "Protein may easily be made over by the animal into its own substance, i. e., into muscles, tendons and the various working tissues and membranes which are necessary parts of the animal machine, because it is made up of the same kind of materials—is, chemically speaking, of the same composition."

Fiber and the nitrogen free extract, on the other hand, probably cannot serve at all for building up muscles and other parts of the growing animal, and cannot restore the waste and wear of those parts of mature animals, because they are of a very different nature. They contain no nitrogen, an element which enters into all animal tissues (albuminoids) to the extent of some sixteen per cent. of the dry matter.

Fiber and nitrogen free extract cannot restore the worn out muscles or membranes of the animal any more than coal can be made to renew the worn out packing, bolts, flues, valves and gearing of a steam engine. Protein is to the ox or man what brass and iron are to the machine—the materials of construction and repair.

Fat, fiber and nitrogen free extract are, furthermore, to the animal very much what coal and other fuel are to the steam engine. Their consumption generates the power which runs the mechanism. Their burning (oxidation) in the blood of animals produces the results of life, just as the combustion of coal in the fire-box of a steam engine produces the motion and power of the machine.

There is, however, this difference between the engine and the animal: The former may be stopped for repairs; the latter may run at a low rate, but if stopped it cannot resume work; hence the repairs of the animal must go on simultaneously with its wastes. Therefore, the material of which it is built must admit of constant replacement, and the dust and shreds of its wear and tear must admit of escape without impeding action. The animal body is as if an engine were fed not only with coal and water, but with iron, brass and all the materials for its repair, and also as if the engine consumed its own worn out parts, voiding them as ashes or gas and smoke.

Protein, or the blood and tissue former, is thus consumed in the animal, as well as the fat, fiber and nitrogen free extract, or fuel proper. The fact that protein admits of consumption implies that when the proper fuel is insufficient protein may itself serve as fuel. Such is the case in fact. But, nevertheless, the two classes of substances have distinct effects in animal nutrition

DIGESTIBILITY OF FODDERS.

When an animal takes food into its stomach part of the food is broken down, digested and dissolved by the action of the juices of the stomach; but part resists this action, and passes through the animal undigested. It is only the part that has been actually digested and taken into the circulation of the animal that does any good, and it is this part alone which commands our attention when studying the subject of cattle feeding.

There is no constant ratio between the digestible and undigestible parts of the ingredients of different fodders; each one has to be analyzed, and its digestible portion determined by itself. For this we resort to feeding experiments, in which fodders of known composition are fed to animals in weighed quantities, and the fæces, which represent the undigestible portions, carefully collected, weighed and analyzed. The difference between the amount fed and that left undigested is the digestible part.

Many practical tests have been made in Germany especially, and during the past few years the stations of this country have done considerable in this line, and have obtained results which are probably more accurate for the fodders raised in the United States. From the results of the German investigations Wolff, an eminent agricultural chemist, has developed tables of the digestibility of feeding stuffs.

The following table—No. 1—gives the percentage composition and digestibility of the several ingredients of the various feeding stuffs. These figures are compiled from American Experiment Station results and the German tables:

Average Composition of American Feeding Stuffs.

FEEDING STUFFS.	No of analyses.	PERCENTAGE COMPOSITION.							PER CE DIGESTI MATTE		
		Water.	Ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Organic matter.	Crude protein.	Carbohydrates	Ether extract.
Green fodders and silage.											
asture grass	..	80.0	2.0	3.5	4.0	9.7	.8	18.0	2.6	10.6	.5
reen fodder corn (maize)	126	79.3	1.2	1.8	5.0	12.2	.5	19.5	1.3	11.8	.4
lfalfa (lucern)	23	71.8	2.7	4.8	7.4	12.3	1.0	25.5	3.6	11.4	.4
Green clover	43	70.8	2.1	4.4	8.1	13.5	1.1	27.1	2.9	14.1	.7
Alsike clover, in bloom	4	74.8	2.0	3.9	7.4	11.0	.9	23.2	2.7	13.1	.6
Rye fodder	7	76.6	1.8	2.6	11.6	6.8	.6	21.6	2.1	14.1	.4
Oat fodder	6	62.2	2.5	3.4	11.2	19.3	1.4	35.3	2.7	22.7	1.0
Sorghum fodder	11	79.4	1.1	1.3	6.1	11.6	.5	19.5	.8	12.7	.4
Red top, in bloom	5	64.8	2.3	3.3	9.4	19.1	1.2	32.9	2.3	20.5	.7
Meadow fescue, in bloom	4	69.9	1.8	2.4	10.8	14.3	.8	28.3	1.7	17.8	.5
Timothy	56	61.6	2.1	3.1	11.8	20.2	1.2	36.3	2.2	23.0	.7
Blue grass	18	65.1	2.8	4.1	9.1	17.6	1.3	32.1	2.9	19.2	.8
Prickly comfrey	14	88.4	2.2	2.4	1.6	5.1	.3	9.4	1.4	4.6	.2
Corn silage	99	79.1	1.4	1.7	6.0	11.1	.8	19.5	.8	11.6	.7
Corn silage, Wisconsin analyses	17	73.6	2.1	2.7	7.8	12.9	.9	24.2	1.3	14.0	.7
Clover silage	5	72.0	2.6	4.2	8.4	11.6	1.2	25.4	2.0	13.5	1.0
Sorghum silage	6	76.1	1.1	.8	6.4	15.3	.3	22.8	.6	14.9	.2
Hay and dry coarse fodders.											
Fodder corn (maize), field cured	35	42.2	2.7	4.5	4.3	34.7	1.6	55.1	2.6	33.3	1.1
Same, Wisconsin analyses	5	9.0	4.2	6.5	22.1	56.5	1.7	86.8	3.7	40.4	1.2
Corn stalks (stover), field cured	60	40.1	3.4	3.8	19.7	31.9	1.1	56.5	2.0	33.4	.6
Hay from red clover	38	15.3	6.2	12.3	24.8	38.1	3.3	78.5	6.5	34.9	1.6
Hay from mammoth clover	10	21.2	6.1	10.7	24.5	33.6	3.9	72.7	5.7	32.0	1.9
Hay from alfalfa (lucern)	21	8.4	7.4	14.3	25.0	42.7	2.2	84.2	7.6	37.8	1.3
Hay from alsike clover	9	9.7	8.3	12.8	25.6	40.7	2.9	82.0	6.8	36.8	1.4
Oat hay	6	8.9	6.2	7.6	29.3	45.1	2.9	84.9	4.3	46.4	1.5
Timothy hay	68	13.2	4.4	5.9	29.0	45.0	2.5	82.4	3.0	43.9	1.2
Hay from mixed meadow grasses	11	16.0	4.6	6.4	29.9	41.0	2.1	79.4	3.6	42.7	1.0
Hay from Hungarian grass	12	7.7	6.0	7.5	27.7	49.0	2.1	86.3	4.5		1.0
Marsh hay	2	7.9	5.2	7.8	30.1	46.3	2.7	86.9	3.5	4...	1.7

Average Composition of American Feeding Stuffs.—Continued.

FEEDING STUFFS.	No. of analyses.	PERCENTAGE COMPOSITION.							PER CENT. DIGESTIBLE MATTER.		
		Water.	Ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Organic matter.	Crude protein.	Carbo-hydrates.	Ether extract.
Oat straw	12	9 2	5 1	4.0	37.0	42.4	2.3	85.7	1.6	41.4	.7
Barley straw*	97	14.2	5.7	3.5	36.0	39.0	1.5	80.1	.9	41.3	.6
Wheat straw	7	9.6	4.2	3.4	38.1	43.4	1.3	86.2	.8	37.9	.5
Rye straw	7	7.1	3.2	3.0	38.9	46.6	1.2	89.7	.8	42.7	.4
Buckwheat straw	8	9.9	5.5	5.2	43.0	35.1	1.3	84 6	2.3	37.7	.6
Pea vine*	14	13.6	6.6	9.0	35.5	33.7	1.6	79.8	4.3	32.2	.8
Roots and Tubers.											
Potatoes	12	78.9	1.0	2.1	.6	17.3	.1	20.1	1.4	16.1	.1
Sweet potatoes	6	71.1	1.0	1.5	1.3	24.7	.4	27.9	.9	22.2	.3
Red beets	9	88.5	1.0	1.5	.9	8.0	.1	10.5	.9	7.6	.1
Sugar beets	19	86.5	.9	1.8	.9	9.8	.1	12.6	1.1	9.3	.1
Mangel-wurzels	9	90.9	1.1	1.4	.9	5.5	.2	8.0	1.1	4.8	.2
Rutabagas	4	88.6	1.2	1.2	1.3	7.5	.2	10.2	.9	7.1	.2
Turnips	3	90.5	.8	1.1	1.2	6.2	.2	8.7	.6	5.5	.2
Carrots	8	88.6	1.0	1.1	1.3	7.6	.4	10.4	1.0	7.1	.3
Grains and Mill Products.											
Corn (maize)	208	10.9	1.5	10.5	2.1	69.6	5.4	87.6	7.1	62.7	4.3
Corn and cob meal	7	15.1	1.5	8.5	6.6	64.8	3.5	83.4	6.5	56.3	2.9
Corn cob	18	10.7	1.4	2.4	30.1	54.9	.5	87.9	1.6	43.9	.3
Corn bran	2	10.9	1.7	9.4	4.8	67.3	5.9	87.4	6.2	50.9	3.4
Oats	30	11.0	3.0	11.8	9.5	59.7	5.0	86 0	9.1	44.7	4.1
Oat shorts*	6	10.0	5.2	16.2	7.5	54.5	6.6	84.8	12.6	45.7	5.4
Oat feed	4	7.7	3.7	16.0	6.1	59.4	7.1	88.6	12.5	46.9	2.8
Oat dust	2	6.5	6.9	13.5	18.2	50.2	4.8	86.6	8.9	38.4	5.1
Barley	10	10.9	2.4	12.4	2.7	69.8	1.8	86.7	9.5	66.1	1.2
Barley screenings	2	12 2	3.6	12.3	7.3	61.8	2.8	84.2	9 3	57.3	1.8
Wheat	310	10.5	1.8	11.9	1.8	71.9	2.1	87 7	9.2	64.9	1.4
Wheat bran—roller process	7	12.0	5 6	16.1	8.4	53.7	4.2	82.4	12 6	44.1	2.9
Wheat bran—old process	9	12.0	4.9	18 0	8.1	53.2	3.8	83 1	10.1	47.5	2.6
Wheat shorts	12	11.8	4.6	14.9	7.4	56.8	4.5	83.6	11.6	45.4	3.2
Wheat middlings	33	12.1	3.4	15.7	4.7	60.2	4.0	84.5	12.2	47.2	2.9
Wheat screenings	10	11.6	2.9	12.5	4.9	65 1	3.0	85.5	9.8	51.0	2.2

Average Composition of American Feeding Stuffs.—Continued.

FEEDING STUFFS.	No. of analyses.	PERCENTAGE COMPOSITION.							PER CENT DIGESTIBLE MATTER.		
		Water.	Ash.	Crude protein.	Crude fibre.	Nitrogen-free extract.	Ether extract.	Organic matter.	Crude protein.	Carbohydrates.	Ether extract.
Rye	6	11.6	1.9	10.6	1.7	72.5	1.7	86.5	8.3	65.5	1.2
Rye bran	7	11 6	3.6	14.7	3.5	63.8	2.8	84.8	9.7	48.0	1.6
Rye shorts	1	9.3	4.9	18.0	5.1	59.9	2.8	85.8	11.9	45.1	1.6
Buckwheat	8	12.6	2.0	10.0	8.7	64.5	2.2	85.4	7.7	49.2	1.8
Buckwheat bran	2	10 5	3.0	12.4	31.9	38.8	3.3	86.5	7.4	30.4	1.9
Buckwheat shorts	2	11 1	5.1	27.1	8.3	40.8	7.6	83.8	21.1	33.5	5.5
Buckwheat middlings	6	12.7	5.1	28.2	4.2	42.3	7.5	82.2	22.0	33.4	5 4
Rice	10	12.4	4	7.4	.2	79.2	.4	87.2	4.8	72.2	.3
Rice bran	5	9.7	10.0	12.1	9.5	49.9	8.8	80.3	5.3	45.1	7.3
Rice hulls	3	8.2	13.2	3.6	35.7	38.6	.7	78.6	1.6	44.5	.6
Rice polish	4	10.0	6.7	11.7	6.3	58.0	7.3	83.3	9.0	56.4	6.5
Pea meal	2	10.5	2.6	20.2	14.4	51.1	1.2	86.9	18.0	56.0	.9
Sorghum seed	10	12.8	2.1	9.1	2.6	69 8	3.6	85.1	7.0	52.1	3.1
Cow pea	5	14 8	3.2	20.8	4.1	55.7	1.4	82.0	18.3	54.2	1.1
Soja bean	8	10.8	4.7	34.0	4.8	28.8	16.9	84.5	29.6	17.9	15.9
Miscellaneous Feeds.											
Malt sprouts	5	9.6	5.9	24.8	11.0	47.0	1.7	84.5	19.8	36.2	1.7
Brewers' grains	15	75.7	1 0	5.4	3.8	12.5	1.6	23.3	3 9	9.5	1.3
Brewers' grains, dried	5	7.7	3.6	22.2	12.3	47 9	6.3	88.7	16.2	35.5	5.3
Hominy chops	12	11.1	2.5	9.8	3.8	64.5	8.3	86.4	8.9	61.9	6.3
Corn germ	3	10.7	4.0	9.8	4.1	64 0	7.4	85 3	8.9	61.4	5.6
Germ meal	3	8.6	1.0	10.9	10.2	64.0	5.4	90.4	9.3	63.6	4.1
Gluten meal	32	9.0	.7	29.4	1.6	52.4	7.4	89.7	25.0	49.4	5.6
Grano-gluten	1	5.8	2.8	31 1	12.0	33.4	14.9	91.4	26.5	35.4	11.8
Starch feed, wet	12	65.4	.3	6.1	3.1	22.0	3.1	34.3	5.5	21.7	2.3
Cotton seed meal	37	8.2	7 2	42.4	5.6	23.8	12.9	84.6	36.9	18.1	12.0
Cotton seed hulls	10	9.9	2 9	4.2	47.4	33 2	2.2	87.2	1.0	26.2	1.8
Linseed meal, old process	21	9.2	5.7	32.9	8.9	35.4	7.9	85.1	28.3	32.8	7.1
Linseed meal, new process	14	10.1	5.8	33.2	9.5	38.5	3.0	84.1	27.2	32.9	2.7
Palm nut meal*	600	10.4	4.3	16 8	21.0	35.0	9.5	85.3	16.0	52.6	9.0
Apples*	36	81.8	.5	.4	1.5	12 5	.3	14.7	.3	12.8	.2

Average Composition of American Feeding Stuffs.—Continued.

FEEDING STUFFS.	No. of ana'yses.	PERCENTAGE COMPOSITION.							PER CENT. DIGESTIBLE MATTER.		
		Water.	Ash.	Crude protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.	Organic matter.	Crude protein.	Carbo-hydrates.	Ether extract.
Apple pomace	7	76.7	.5	1.4	3.9	16.2	1 8	22.8	1.0	11.9	1.1
Dried blood*	3	8.5	4.7	84.4	...	......	2.5	86.8	59.1	...	2.3
Skimmed milk*	96	90.4	.7	3.3	....	4.7	.8	8.9	3.1	4 7	.8
Butter milk*	85	90.1	.7	4.0	....	4.0	1.1	9.2	3.9	4.0	1.1
Whey*	46	93.4	.7	.9	....	4.8	.3	5.9	.8	4.7	.2

DIGESTION COEFFICIENTS.

These are factors representing the per cent. which is digestible of the total amount of the several ingredients found in a fodder. They have been determined by actual experiments in feeding, or in some cases, by artificial digestion. The following table, No. II, gives the digestion coefficients (or per cent of digestibility) for the several fodders. An example will make their use plain.

In table I we find the composition of timothy hay given; it is there seen that in 100 pounds of the hay 5.90 pounds are digestible; from table II we find that 50.80 per cent of this protein is digestible, 5.90 x .508 = 3.00; hence each 100 pounds of timothy hay contains 3 pounds of digestible protein. The digestible portions of the other ingredients are calculated in the same way.

TIMOTHY HAY.

	Total Amt.		Per Cent. of Digestibility.		Per Cent or Amount Digestible.
Protein	5.90	x	50.80	=	3.00
Carbohydrates	74.00	x	59.30	=	43.90
Ether extract	2.50	x	48.00	=	1.20

To calculate to amount digestible per ton, multiply by 20; thus 3.00 x 20 = 60 pounds of digestible protein per ton of timothy hay.

Table II.—Digestion Coefficients.

	Crude Protein.	Carbo-hydrates.	Ether Extract.
Green Fodders and Silage—			
Green fodder corn (maize)	72.22	68.60	80.00
Alfalfa (lucern)	75.00	57.80	40.00
Green clover	65.80	65.20	63.60
Alsike clover in blossom	69.20	71.10	66.60
Rye fodder	80.70	76.60	66.60
Oat fodder	79.40	74.40	71.40
Sorghum fodder	61.50	71.70	80.00
Red Top in blossom	69.60	71.20	58.30
Meadow fescal in blossom	70.80	70.90	62.50
Timothy	70.90	71.80	58.30
Bluegrass	70.70	71.90	61.50
Prickly confrey	58.30	68.60	66.60
Corn silage	47.00	67.80	87.50
Corn silage,	48.10	67.60	77.70
Clover silage	47.80	67.50	83.30
Sorghum silage	75.00	68.60	66.60
Hay and Dry Coarse Fodders—			
Fodder corn (maize) field cured	57.70	85.30	68.70
Same, Wisconsin analysis	56.90	68.80	70.50
Corn stalks, (stover), field cured	52.60	64.70	54.50
Hay from Red clover	52.80	55.40	48.40
Hay from Mammoth clover	53.20	55.00	48.70
Hay from Alfalfa (lucern)	53.10	55.80	59.00
Hay from Alsike clover	53.10	55.50	48.20
Oat hay	56.50	62.30	51.70
Timothy hay	50.80	59.30	48.00
Hay from mixed meadow grasses	56.20	60.20	47.60
Hay from Hungarian grass	60.00	60.40	47.60
Mash hay	44.90	58.50	62.90
Oat straw	40.00	52.10	30.40
Barley straw	25.70	55.00	40.00
Wheat straw	23.50	46.50	38.40
Rye stsaw	26.60	49.90	33.30
Buckwheat straw	44.20	48.50	46.10
Pea vine	47.70	46.60	50.00
Roots and Tubers—			
Potatoes	66.60	89.90	100.00
Sweet potatoes	60.00	85.30	75.00
Red beets	60.00	85.30	100.00
Sugar beets	61.10	86.90	100.00
Mangewertzel	78.50	75.00	100.00
Rutabagas	75.00	80.60	100.00
Turnips	54.50	[illegible]4.30	100.00
Carrots	90.90	79.70	75.00
Grains and Mill Products—			
Corn (maize)	67.60	87.40	77.70
Corn and cob meal	76.40	78.80	82.80
Corn cob	66.60	51.60	60.00

Table II.—Digestion Coefficients, Continued.

	Crude Protein.	Carbo-hydrates.	Ether Extract.
Corn bran	65.90	70.50	57.60
Oats	77.10	64.50	82.00
Oat shorts	77.70	73.70	81.80
Oat feed	78.10	71.60	39.40
Oat dust	65.90	56.10	.....
Barley	76.60	91.10	66.60
Barley screenings	75.60	82.90	64.20
Wheat	77.30	88.00	66.60
Wheat bran—roller process	78.20	71.00	69.00
Wheat bran—old process	77.60	71.60	68.40
Wheat shorts	77.80	70.70	71.10
Wheat middlings	77.70	72.70	72.50
Wheat screenings	70.40	72.80	73.30
Rye	78.30	88.20	70.50
Rye bran	65.90	71.30	57.10
Rye shorts	66.10	69.30	57.10
Buckwheat	77.00	67.20	81.80
Buckwheat bran	59.00	42.90	57.50
Buckwheat shorts	77.80	68.20	72.30
Buckwheat middlings	78.00	71.80	72.00
Rice	64.80	90.90	75.00
Rice bran	43.80	75.90	82.90
Rice hulls	44.40	59.80	85.70
Rice polish	76.90	87.70	89.00
Pea meal	89.10	85.40	75.00
Sorghum seed	76.90	71.90	86.10
Cow pea	87.90	90.60	78.50
Soja bean	87.00	53.20	94.00
Miscellaneous Feeds—			
Malt sprouts	79.80	62.40	100.00
Brewers grains	72.20	58.20	81.20
Brewers grains, dried	72.90	58.90	84.10
Hominy chops	90.80	90.60	75.90
Corn germ	90.80	90.10	75.60
Germ meal	85.30	85.70	75.90
Gluten meal	85.00	91.40	75.60
Grano-gluten	85.20	77.90	75.80
Starch feed, wet	90.10	86.40	74.10
Cotton seed meal	87.00	61.50	95.30
Cotton seed hulls	23.80	32.50	81.80
Linseed meal, old process	86.00	74.00	89.80
Linseed meal, new process	81.90	68.50	90.00
Palm nut meal	95.20	89.10	94.70
Apples	75.00	91.40	66.60
Apple pomace	71.40	59.20	84.60
Dried blood	70.02	.....	92.00
Skimmed milk	93.90	100.00	100.00
Butter milk	97.50	100.00	100.00
Whey	88.80	97.90	100.00

NUTRITIVE RATIO.

By this is meant the proportion existing between the digestible protein, or muscle forming parts of the fodder, and the digestible carbohydrates, or heat producing part; and fat in a ration—the fat being multiplied by 2.2 and added to the carbohydrates, as the heating power of fat is 2.2 times that of carbohydrates.

For example, let us use the timothy hay again. We find timothy hay contains, of:

Digestible carbohydrates (nitrogenous free extracts crude fiber)	43.90
Digestible fat (Ether Extract) 1.20 x 2.2 =	2.64
Total digestible non-nitrogenous matter	46 54

Digestible protein, 3.00.

46.54 : 3.00 = 15.51.

Timothy hay has 15.51 times as much digestible non-nitrogenous matter as nitrogenous matter. That is, it has 1 part of digestible nitrogenous matter, or protein, to 15.31 parts of non-nitrogenous matter, or carbohydrates, hence we say the nutritive ratio of timothy hay is 1:15.51.

A vast amount of work has been done by scientists upon the problem of systematic feeding of farm animals.

As an outcome of these investigations, it was discovered that the nitrogenous substance played a very important part in animal nutrition, and that a ration containing a large proportion of these substances gives the best results, other things being equal. Certain feeding standards have been constructed, which give the required amount total dry matter, of digestible matter, and the proportion of the different nutrients in the digestible matter.

This work has been done mostly by German investigators, foremost among whom is Dr. Emil Wolff. The following table, No. III, giving the feeding standards for farm animals, as compiled by him.

It is not likely that in all cases these standards will meet the requirements of our American farmers. American experiments will in time revise these standards.

Table III. Feeding Standards.—According to Wolff.

(Per day and per 1,000 lbs. live weight.)

	Total Organic Substance.	Nutritive (digestible) Substances.			Total Nutritive Substances..........	Nutritive Ratio ....
		Crude Protein..	Carbohydrates..	Ether Extract...		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
1. Steers at rest in stall................	17.5	0.7	8.0	0.15	8.85	1:12.0
2. Wool sheep, coarser breeds..........	20.0	1.2	10.3	0.20	11.70	1:9.0
Wool sheep, finer breeds	22.5	1.5	11.4	0.25	13.15	1:8.0
3. Steers moderately worked...........	24.0	1.6	11.3	0.30	13.20	1:7.5
Steers heavily worked...............	26.0	2.4	13.2	0.50	16.10	1:6.0
4. Horses moderately worked..........	21.0	1.6	10.0	0.50	12.10	1:7.0
Horses heavily worked..............	23.0	2.5	12.1	0.70	15.30	1:5.5
5. Milch cows.......................	24.0	2.5	12.5	0.40	15.40	1:5.4
6. Fattening steers, 1st period..........	27.0	2.5	15.0	0.50	18.00	1:6.5
Fattening steers, 2d period...........	26.0	3.0	14.8	0.70	18.50	1:5.5
Fattening steers, 3d period...........	25.0	2.7	14.8	0.60	18.10	1:6.0
7. Fattening sheep, 1st period	26.0	3.0	15.2	0.50	18.70	1:5.5
Fattening sheep, 2d period...........	25.0	3.5	14.4	0.60	18.50	1:4.5
8. Fattening swine, 1st period..........	36.0	5.0	27.5		32.50	1:5.5
Fattening swine, 2d period...........	31.0	4.0	24.0		28.00	1:6.0
Fattening swine, 3d period...........	23.5	2.7	17.5		20.20	1:6.5
9. Growing cattle:						
Average live weight.						
Age. Months. *Per head.*						
2–3 165 lbs......	22.0	4.0	13.8	2.0	19.8	1:4.7
3–6 330 lbs......	23.4	3.2	13.5	1.0	17.7	1:5.0
6–12 550 lbs	24.0	2.5	13.5	0.6	16.6	1:6.0
12–18 770 lbs......	24.0	2.0	13.0	0.4	15.4	1:7.0
18–24 940 lbs......	24.0	1.6	12.0	0.3	13.9	1:8.0
10. Growing sheep:						
5–6 62 lbs......	28.0	3.2	15.6	0.8	19.6	1:5.5
6–8 73 lbs......	25.0	2.7	13.3	0.6	16.6	1:5.5
8–11 84 lbs......	23.0	2.1	11.4	0.5	14.0	1:6.0
11–15 90 lbs......	22.5	1.7	10.9	0.4	13.0	1:7.0
15–20 95 lbs......	22.0	1.4	10.4	0.3	12.1	1:8.0
11. Growing fat pigs:						
2–3 55 lbs......	42.0	7.5	30.0		37.5	1:4.0
3–5 110 lbs......	34.0	5.0	25.0		30.0	1:5.0
5–6 137 lbs......	31.5	4.3	23.7		28.0	1:5.0
6–8 187 lbs......	27.0	3.4	20.4		23.8	1:6.0
8–12 275 lbs......	21.0	2.5	16.2		18.7	1:6.5

ANALYTICAL DATA.

ALFALFA.

Station Number 580. *Cut July 7th, before bloom.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	7.548	....	.....	......
Ash	6.875	7.437	....	....
Ether extract	2.259	2.443	1.433	1.441
Protein	12.576	13.610	6.667	7.226
Nitro. free extract	46.962	50.790	39.462	41.582
Crude fiber	27.780	25.720		

Nutritive ratio, 1:6.39.

ALFALFA.

Station Number 581. *Cut July 14th, past bloom.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	8.063	....	....	....
Ash	7.180	7.809	....	......
Ether extract	2.777	3.021	1.638	1.782
Protein	4.577	4.979	2.429	2.642
Nitro. free extract	46.743	50.841	43.190	46.982
Crude fibre	30.660	30.660		

Nutritive ratio, 1:19.3.

ALFALFA.

Station Number 582. *Cut July 14th, full bloom*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	7 428	....	....	....
Ash	5.875	6.346	....	....
Ether extract.	2.805	3.030	1.655	1.788
Protein	13.306	14.380	6.965	7.636
Nitro. free extract	40 336	43.570	39.386	42.544
Crude fiber	30.250	32.674		

Nutritive ratio, 1:6.18.

ALFALFA.

Station Number No. 583. *Cut July 14th, full bloom.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	7.776	....	....	....
Ash	7.120	7.721	....	....
Ether extract.	2.624	2.856	1.548	1.676
Protein	12.554	12.610	6.666	7.427
Nitro. free extract	41.676	45.188	39.018	43.308
Crude fiber	28.250	30.635		

Nutritive ratio, 1:6.37.

ALFALFA.

Station Number 584. *Cut July 29th, past bloom.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	7.605	....	....	....
Ash	6.565	7.104	....	....
Ether extract	3.956	4.281	2.335	2.526
Protein	5.617	6.079	2.983	3.228
Nitro. free extract	46.012	49.809	42.551	46.055
Crude fiber	30.245	32.727		

Nutritive ratio, 1:15.9.

CORN FODDER.

Station Number 585.

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	5.286	....	....	....
Ash	7.215	7.617	....	....
Ether extract	2.618	2.764	1.899	1.899
Protein	22.461	23.720	12.960	13.690
Nitro. free extract	41.660	43.980	53.244	56.213
Crude fiber	20.760	21.920		

Nutritive ratio, 1:4.41

CORN FODDER.

Station Number 586.

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	9.520	.....	....	....
Ash	5.560	6.569	....	....
Ether extract	2.505	2.768	1.721	1.902
Protein	20.151	22.270	11.630	12.850
Nitro. free extract	38.989	42.678	53.111	58.340
Crude fiber	23.275	25.715		

Nutritive ratio, 1:4.89.

CORN FODDER.

Station Number 587.

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	8.491	.....	....	....
Ash	4.535	4.956	....	....
Ether extract	1.598	1.746	1.098	1.200
Protein	13.307	14.545	7.680	8.390
Nitro. free extract	57.434	62.770	61.475	67.176
Crude fiber	14.635	15.983		

Nutritive ratio, 1:8.31.

CORN FODDER.

Station Number 588.

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	7.992	....	....	....
Ash	5.945	6 462	....	....
Ether extract	1.589	1.727	1.092	1.187
Protein	4.761	5.175	2.747	2 986
Nitro. free extract	57.893	62.916	67.995	73.900
Crude fiber	21.820	23.720		

Nutritive ratio, 1:25.6.

POLISH WHEAT.

Station Number 589.

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water	10.402	....	....	....
Ash	3.330	3.716	....	....
Ether extract	.732	.817	.488	.544
Protein	32.747	36.550	25.310	28.260
Nitro. free extract	50.854	56.757	46.454	51.847
Crude fiber	1.935	2.160		

Nutritive ratio, 1:1.87

BUCKWHEAT.

Station Number 590. *Whole Kernal.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Air Dried	Water Free	Air Dried	Water Free
Water...........	9.867	....	....	....
Ash..........	2.800	3.107	....	....
Ether extract.....	5.677	6.298	4.644	5.152
Protein.........	11.977	13.290	9.225	10.230
Nitro. free extract	61.679	68.429	46.824	51.948
Crude fiber.......	8.000	8.876		

Nutritive ratio, 1:6.19.

BEET LEAVES.

Station Number 591. *Improved Klein Wanzlebener.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance.	Air Dried	Original Substance	Air Dried
Water...........	88.73	7.373	....	....
Ash...........	1 994	16.400	....	....
Ether extract.....	.219	1.804	.100	.830
Protein..........	2.308	18.966	1.340	11.000
Nitro. free extract	5.791	47.602	5.791	47.602
Crude fiber.......	.955	7.855	....	....

Nutritive ratio, 1:5.97.

BEET LEAVES.

Station Number 592. *Variety Unknown.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance.	Air Dried	Original Substance	Air Dried
Water	87.950	6.900		
Ash	2.284	17.650		
Ether extract.	.475	3.671	.2185	1 690
Protein	.665	5.140	.3857	2.98
Nitro. free extract	7.613	58.824	7.6130	58.824
Crude fiber.	1.011	7.815		

Nutritive ratio, 1:20.96.

BEET LEAVES.

Station Number 593. *Desprez.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance.	Air Dried	Original Substance	Air Dried
Water	88.890	7.481		
Ash	2.414	20.105		
Ether extract	.395	3.292	.1817	1.5143
Protein	2.054	17.104	1.1913	9.9203
Nitro. free extract	5.295	44.143	5.2950	44.1430
Crude fiber	.945	7.875		

Nutritive ratio, 1:4.78.

SUGAR BEET.

Station Number 595. *Verbesseter Klein Wanzlebener.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance	Air Dried	Original Substance	Air Dried
Water	88.63	4.466	....	....
Ash	.490	4.120	....	....
Ether extract	.122	.962	.1221	.962
Protein	.499	4.197	.3048	2.564
Nitro. free extract	9.574	80.495	8.9150	74.955
Crude fiber	.685	5.760		

Nutritive ratio, 1:30.13.

SUGAR BEET.

Station Number 597. *Klein Wanzlebener.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance.	Air Dried	Original Substance	Air Dried
Water	88.75	6.851	....	....
Ash	.649	5.380	....	....
Ether extract	.415	3.442	.4156	3.442
Protein	1.148	9.508	.7014	5.810
Nitro. free extract	8.508	70.424	7.8540	65.017
Crude fiber	.530	4.395		....

Nutritive ratio, 1:12.50.

SUGAR BEETS.

Station Number 598. *Simon Le Grand.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance	Air Dried	Original Substance	Air Dried
Water	87.98	5.028	....	.....
Ash	.5505	4.350	....	......
Ether extract	.2740	2.165	.2740	2.165
Protein	.5785	4.571	.3534	2.793
Nitro. free extract	9.9335	78.491	9.2255	72.822
Crude fibre	.6828	5.395		

Nutritive ratio, 1:27.80.

SUGAR BEETS.

Station Number 599. *Vilmorin Ameliorее.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance	Air Dried	Original Substance	Air Dried
Water	88.44	6.944	.. .	. ...
Ash	.5477	4.410	....	......
Ether extract	.3609	2.906	.3609	2.906
Protein	.7563	6.090	.4618	3.721
Nitro. free extract	9.2267	74.270	8.5987	69.650
Crude fibre	.6682	5.380		

Nutritive ratio, 1:20.34.

SUGAR BEET.

Station Number 600. *Vilmorin Ameliorec.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance	Air Dried	Original Substance	Air Dried
Water	88.30	6.661	....	....
Ash	.446	3.560	....	....
Ether extract	.256	2.050	.256	2.050
Protein	.399	3.186	.2437	1.946
Nitro. free extract	9.892	78.898	9.2115	73.468
Crude fiber	.707	5.645		

Nutritive ratio, 1:40.11.

SUGAR BEET.

Station Number 601. *Florimond Desprez.*

Constituents.	Percentage Composition.		Per Cent Digestible.	
	Original Substance.	Air Dried	Original Substance	Air Dried
Water	87.93	6.940	....	....
Ash	.4778	3.685	....	....
Ether extract	.1005	.775	.1005	.775
Protein	.5435	4.191	.3321	2.561
Nitro. free extract	10.2355	78.914	9.5139	73.2523
Crude fiber	.7127	5.495		

Nutritive ratio, 1:29.32.

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GRAIN—Thick and Thin Seeding.

POTATOES—Different Dates of Planting.

NEVADA STATE UNIVERSITY.

Agricultural Experiment Station.

BULLETIN NO. 27.

RENO, NEVADA, DECEMBER, 1894.

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Address all communications to

THE DIRECTOR,
Agricultural Experiment Station.
Reno, Washoe County, Nevada.

GRAIN—Thick and Thin Seeding.

POTATOES—Different Dates of Planting.

R. H. McDowell.

The grain crop, as a factor in our national economy, is one of vast importance, especially since we use hundreds of millions to measure its financial rank. When we consider its history for even fifty years we see how far-reaching is its influence. It is most substantial in supplying the needs of all classes of people, as it appears in a large variety of ways prepared for the table, and is prominent in giving quality and increased value to our beef, mutton and pork.

A single plant in Chicago uses 10,000 bushels of oats daily—principally for rolling. In raising crops or animals, "well begun is half done." With grain we find among the necessities for good returns a productive soil well prepared, the best seed in reasonable amount, good judgment and prompt action in choosing a date for seeding, irrigation and harvest.

Some varieties of grain possess superior merit in the line of milling qualities, in yield, in early ripening, in not shelling easily and in having straw that stands up. These same best varieties give better results—all points considered—by sowing the right amount of first-class seed. The best filled kernels will produce the strongest plants. As a general rule it may be said that wheat that grades as screenings is worse than thrown away if used for seed.

Screenings have a feeding value, but when used for seed produce inferior plants that impede, to some extent, the growth of the better portion of the crop. The following tables give results for four years with different amounts of seed wheat. The variety used, White Australian, is one of the best for milling. The yield for 1894 was increased over that for other years by the use of well rotted manure, thirty-eight loads per acre, of 5,800 pounds per load, were used. The attention of farmers is asked to note the increase in yield after one application of barnyard manure.

DATES OF SEEDING.

In 1891 it was March 22 when the writer arrived at the Station. The surveying for plats, removal of a large amount of rock, some of which required powder, the breaking of alfalfa with six horses, and cross plowing took the time till it was May 7th before we could sow. The growth for this season was uniform, and yield 1,575 pounds per acre. It was decided to sow earlier in '92, and March 22 was selected. The original stand was good, but sharp frosts with hard winds checked the growth till at times it looked like a case of plow under. For '93 and '94 the seeding dates were placed in April. Some of our grain farmers sow April 15, while others prefer to sow earlier, claiming that less water is required.

WHEAT—1891.

NAME.	Seed—Rate per Acre; Lbs.	Seed—Am't drilled; Lbs. Ozs.	Area—Acres	Date Drilled	Date Full Head	Date Ripe	Length of Straw—Inches	Length of Head—Inches	No. of Irrigations	YIELD.					
										Less Seed Drilled.		Per Plat.		Rate Per Acre.	
										Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.
White Australian	45	11–4	¼	5–7	7–26	8–26	46	3½ to 5	9	334	4	345	8	1382	....
White Australian	75	18–12	¼	5–7	7–23	8–26	39 to 46	3 to 4	9	367	4	386	....	1544	....
White Australian	90	22–8	¼	5–7	7–23	8–26	42	3 to 4	9	333	8	356	....	1424	....
White Australian	105	26–4	¼	5–7	7–23	8–26	47 to 48	3 to 4	9	367	8	393	12	1575	....

WHEAT—1892.

White Australian	45	11–4	¼	3–22	7–2	8–5	32 to 40	3 to 3½	9	277	4	288	8	1154	....
White Australian	75	18–12	¼	3–22	7–2	8–5	34 to 38	3 to 3¾	9	301	7	320	3	1280	12
White Australian	90	22–8	¼	3–22	7–2	8–5	37 to 38	3 to 3¾	9	260	3	282	11	1130	12
White Australian	105	26–4	¼	3–22	7–2	8–5	36 to 38	3 to 2½	9	256	11	282	15	1131	12

WHEAT—1893.

NAME.	Seed—Rate per Acre; Lbs.	Seed—Am't drilled; Lbs., Ozs	Area—Acres	Date Drilled	Date Full Head	Date Ripe	Length of Straw—Inches	Length of Head—Inches	No. of Irrigations	YIELD.					
										Less Seed Drilled		Per Plat		Rate Per-Acre.	
										Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs
White Australian	30	7–8	¼	4–11	7–8	8–10	33	3¾	8	264	....	271	8	1086	....
White Australian	45	11–4	¼	4–11	7–8	8–8	33	3¼	8	220	13	232	1	928	4
White Australian	60	15	¼	4–11	7–8	8–9	33	3	8	243	13	258	13	1035	4
White Australian	75	18–12	¼	4–11	7–8	8–9	39	3	8	403	3	421	15	1687	12
White Australian	90	22–8	¼	4–11	7–8	8–9	40	3½	8	359	2	381	10	1526	8
White Australian	105	26–4	¼	4–11	7–8	8–9	39	3½	8	310	14	337	2	1348	8
White Australian	120	30	¼	4–11	7–8	8–9	43	4	8	354	4	384	4	1537	....

WHEAT—1894.

NAME.	Seed—Rate per Acre; Lbs.	Seed—Am't drilled; Lbs., Ozs	Area—Acres	Date Drilled	Date Full Head	Date Ripe	Length of Straw—Inches	Length of Head—Inches	No. of Irrigations	Less Seed Drilled Lbs.	Less Seed Drilled Ozs.	Per Plat Lbs.	Per Plat Ozs.	Rate Per-Acre Lbs.	Rate Per-Acre Ozs
White Australian	30	7–8	¼	4–6	7–12	8–12	46	4¾	8	472	...	479	8	1918	....
White Australian	45	11–4	¼	4–6	7–12	8–12	45	3¾	8	447	6	458	10	1834	8
White Australian	60	15	¼	4–6	7–12	8–12	45	3¾	8	514	12	529	12	2119	....
White Australian	75	18–12	¼	4–6	7–12	8–12	47	4	8	541	12	560	8	2242	....
White Australian	90	22–8	¼	4–6	7–12	8–11	47	3¾	8	560	8	583	....	2332	....
White Australian	105	26–4	¼	4–6	7–12	8–11	49	3¾	8	588	8	614	12	2459	....
White Australian	120	30	¼	4–6	7–12	8–11	48	3½	8	543	....	573	2	2292	8

The following list of questions on seeding was sent to several farmers, who returned answers as given below :

1. How many pounds of wheat do you sow per acre ?
2. Do you clean or screen before sowing ?
3. How many pounds of oats do you sow per acre ?
4. How many pounds of barley do you sow per acre ?
5. How many pounds of rye do you sow per acre ?
6. Do you raise any fall grain ?
7. What yield of wheat do you get per acre ?
8. What yield of oats do you get per acre ?
9. What yield of barley do you get per acre ?
10. How many pounds of alfalfa do you sow per acre ?
11. Do you sow alfalfa alone or with grain ?

R. SADLER, EUREKA.

1. One hundred and twenty pounds per acre ;
2. We clean wheat and use bluestone.
3. Eighty pounds per acre.
4. One hundred pounds per acre.
5. Have not sowed rye for two years.
6. No.
7. One ton.
8. One ton.
9. One ton.
10. Twenty-five pounds per acre.
11. With grain; think that it gets a better start in our soil.

D. H. DILLARD, ST. CLAIR.

1. Eighty pounds per acre.
2. Yes.

3. Seventy-five pounds per acre.
4. Ninety pounds per acre.
5. Seventy pounds per acre.
6. Yes.
7. Twelve hundred to twenty-two hundred pounds per acre.
8. One thousand to two thousand pounds per acre.
9. Fifteen hundred to twenty-five hundred pounds per acre.
10. Twenty pounds per acre.
11. With grain.

D. C. SIMPSON, WELLINGTON.

1. Eighty pounds per acre.
2. Grain all cleaned before sowing.
3. Seventy pounds per acre.
4. I don't raise barley.
5. No rye.
6. I have not tried Fall grain.
7. From thirty to forty bushels, as an average.
8. From thirty to one hundred bushels.
9. From forty to sixty bushels.
10. Twenty pounds of alfalfa and five pounds of timothy, mixed.
11 Sometimes, and sometimes I do not.

Remarks by D. C. Simpson.—In sowing alfalfa seed I have good results sowing with grain or without. If I want a good stand I put on about twenty pounds of alfalfa and five pounds of timothy seed to the acre. Drill in the grain first, then sow the alfalfa and timothy, and harrow light. Last year I seeded to alfalfa about seventy acres, part with grain and part without. I don't think there is any difference in the stand of alfalfa. Both lots were sown in April. This year I have seventy-five acres of alfalfa sowed with grain, and it is as good as I can ask for. This was sown in March. I have sown alfalfa seed from March to September, with good results when the ground had proper care. The secret of raising grain and alfalfa by the irrigating system is knowing when to put on the water. Different ground requires different treatment.

JOHN HARRISON, LOVELOCKS.

1. Eighty pounds of wheat per acre.
2. Yes; clean.
3. Seventy-five pounds of oats per acre.
4. Ninety pounds of barley per acre
5. Never used rye.
6. No.
7. One ton.
8. One and one-half tons per acre.
9. One and one-half tons per acre.
10. Fifteen pounds per acre.
11. With grain.

ANSWERS FROM CARSON VALLEY.

1. Ninety pounds.
2. Yes.

Seventy-five pounds.

4. Ninety-five pounds.
5. ——.
6. No.
7. Seventeen hundred and fifty pounds.
8. Eighteen hundred pounds.
9. Twenty-five hundred pounds.
10. Sixteen pounds.
11. With oats.

We do not raise any fall grain, but know it would be a thorough success on all sandy loams.

GEORGE ALT, RENO.

1. Ninety pounds.
2. Yes.
3. Sixty pounds.
4. Seventy pounds.
5. Seventy pounds.
6. No.
7. Thirty bushels.
8. Fifty bushels.
9. Fifty bushels.
10. Thirty-five pounds.
11. Either way.

POTATOES—*Different Dates of Planting.*

To those who have been so fortunate as to test the eating qualities of Nevada potatoes, it is not necessary to say that our spuds are desirable. The following tables give results for 1894 in testing different dates of planting and different amounts of seed. The figure 1 opposite name of variety indicates the use of half potato for seed, and 2 that a whole potato was used.

Early planted potatoes have suffered severely from frost in April and to some extent in May, but have been much more satisfactory in giving a good stand than late plantings.

NAME.		Hills Planted........	Hills Germinated...	Date Plant'd........	Number Irrigations..	Date Harvested......	YIELD.			
							Large.		Small.	
							Lbs.	Ozs.	Lbs.	Ozs.
Early Rose.	1...............	10	10	3-31	10	10-6	13	8	4	8
	2...............	10	10	3-31	10	10-6	22	8	4	....
Early Sunrise.	1...............	10	10	3-31	10	10-6	21	12	3	8
	2...............	10	10	3-31	10	10-6	21	8	6	....
Summit......	1...............	10	9	3-31	10	10-6	12	13	3	....
	2...............	10	10	3-31	10	10-6	17	....	4	8
St. Patrick....	1...............	10	10	3-31	10	10-6	16	9	5	8
	2...............	10	10	3-31	10	10-6	17	....	4	....
Early Rose...	1...............	10	9	4-10	10	10-6	13	1	3	8
	2...............	10	10	4-10	10	10-6	20	....	4	....
Early Sunrise.	1...............	10	10	4-10	10	10-6	21	8	3	....
	2...............	10	10	4-10	10	10-6	18	8	4	....
Summit......	1...............	10	10	4-10	10	10-6	22	7	3	....
	2...............	10	10	4-10	10	10-6	15	8	4	....
St. Patrick....	1...............	10	10	4-10	10	10-6	22	3	2	....
	2...............	10	10	4-10	10	10-6	17	8	4	....
Early Rose...	1...............	10	10	4-20	10	10-6	13	3	3	....
	2...............	10	10	4-20	10	10-6	19	4	4	....
Early Sunrise.	1...............	10	10	4-20	10	10-6	19	4	3	....
	2...............	10	10	4-20	10	10-6	18	....	4	....
Summit.......	1...............	10	10	4-20	10	10-6	19	11	4	....
	2...............	10	10	4-20	10	10-6	20	....	4	....
St. Patrick....	1...............	10	10	4-20	10	10-6	19	8	3	8
	2...............	10	10	4-20	10	10-6	19	....	3	8

NAME.		Hills Planted........	Hills Germinated....	Date Planted.........	Number Irrigations..	Date Harvested......	YIELD.			
							Large.		Small.	
							Lbs.	Ozs.	Lbs	Ozs.
Early Rose...	1...............	10	10	4–30	10	10–6	17	6	3	8
	2...............	10	10	4–30	10	10–6	15	....	3	8
Early Sunrise.	1	10	10	4–30	10	10–6	16	9	2	8
	2......	10	10	4–30	10	10–6	15	....	6	8
Summit......	1...............	10	10	4–30	10	10–6	18		3	....
	2...............	10	10	4–30	10	10–6	19	8	6	8
St. Patrick....	1...............	10	8	4–30	10	10–6	19	5	3	....
	2............ ..	10	10	4–30	10	10·6	20	5	....	....
Early Rose...	1.............	10	10	5–10	10	10–6	14	5	8	....
	2...............	10	10	5–10	10	10–6	20	....	3	8
Early Sunrise.	1...............	10	10	5–10	10	10–6	16	1	3	....
	2...............	10	10	5–10	10	10–6	16	8	3	....
Summit......	1......	10	9	5–10	10	10–6	14	12	3	8
	2...............	10	9	5–10	10	10–6	16	8	4	8
St. Patrick....	1...............	10	10	5–10	10	10–6	16	11	4	....
	2...............	10	10	5–10	10	10–6	13	....	6	....
Early Rose...	1...............	10	10	5–20	10	10–6	17	4	3	....
	2...............	10	10	5–20	10	10–6	21	....	4	8
Early Sunrise	1...............	10	9	5–20	10	10–6	17	4	3	8
	2...............	10	10	5–20	10	10–6	21	....	3	8
Summit......	1...............	10	9	5–20	10	10–6	17	15	3	....
	2...............	10	10	5–20	10	10–6	18	8	5	8
St. Patrick....	1...............	10	10	5–20	10	10–6	26	....	....	....
	2...............	10	10	5–20	10	10–6	21	8	4	8

NAME.		Hills Planted......	Hills Germinated....	Date Planted......	Number Irrigations..	Date Harvested.....	YIELD.			
							Large.		Small	
							Lbs	Ozs.	Lbs	Ozs.
Early Rose...	1...............	10	8	5-30	10	10-6	19	15	3	8
	2	10	10	5-30	10	10-6	25	8	4	....
Early Sunrise.	1...............	10	8	5-30	10	10-6	23	8	2	8
	2...............	10	9	5-30	10	10-6	27	..	3	....
Summit.	1...............	10	8	5-30	10	10-6	20	7	4	....
	2...............	10	10	5-30	10	10-6	22	...	5	....
St. Patrick....	1...............	10	9	5-30	10	10-6	25	5	2	....
	2.	10	10	5-30	10	10-6	20	8	5	8
Early Rose...	1...............	10	10	6-10	10	10-6	16	3	2	8
	2...............	10	10	6-10	10	10-6	21	....	4	....
Early Sunrise.	1.......	10	10	6-10	10	10-6	17	9	1	8
	2...............	10	10	6-10	10	10-6	18	8	3	8
Summit	1...........	10	7	6-10	10	10-6	11	10	1	8
	2...............	10	10	6-10	10	10-6	22	8	6	....
St. Patrick....	1...............	10	8	6-10	10	10-6	18	6	3	....
	2....	10	10	6-10	10	10-6	18	4	....	....
Early Rose ..	1......	10	9	6-20	10	10-6	9	5	3	....
	2...............	10	10	6-20	10	10-6	12	....	4	8
Early Sunrise.	1...............	10	6	6-20	10	10-6	7	9	1	8
	2......	10	9	6-20	10	10-6	16	....	3	8
Summit	1...............	10	8	6-20	10	10-6	13	....	2	....
	2...............	10	8	6-20	10	10-6	9	....	2	....
St. Patrick....	1...............	10	10	6-20	10	10-6	14	8	3	8
	2...............	10	10	6-20	10	10-6	14	8	6	....

NAME.		Hills Planted......	Hills Germinated...	Date Planted......	Number Irrigations..	Date Harvested....	YIELD.			
							Large		Small.	
							Lbs.	Ozs.	Lbs.	Ozs
Early Rose...	1..............	10	7	6–30	10	10–6	8	2	1	8
	2..............	10	9	6–30	10	10–6	9	....	3	8
Early Sunrise.	1..............	10	4	6–30	10	10–6	2	9	1	8
	2..............	10	6	6–30	10	10–6	8	8	3	....
Summit......	1..............	10	0	6–30	10	10–6	....	.	....	....
	2..............	10	3	6–30	10	10–6	2	8	2	....
St. Patrick....	1..............	10	4	6–30	10	10–6	7	5	2	....
	2..............	10	10	6–30	10	10–6	10	3	8	...

SUMMARY—GRAIN.

1. Clean and screen thoroughly all grain used for seed. It will pay in several ways.

2. It's business to sow seed *enough*; more than enough is seed wasted and the crop injured.

3. During four years trial the seeding of one hundred and five pounds per acre gave best yield for two years and seventy-five pounds best for two years. For 1891 one hundred and five pounds was four ounces better than seventy-five pounds. The writer has handled wheat that yielded eighty-four bushels from three acres of ground. Seed used was forty pounds per acre. It will be noticed in table for 1894 that thirty pounds yields nineteen hundred and eighteen pounds per acre.

4. The amount of seed saved by the farmer in sowing seventy-five pounds per acre instead of ninety pounds would equal three thousand pounds on two hundred acres—at eighty cents per hundred would amount to twenty-four dollars. The same amount per acre saved on two thousand acres would amount to two hundred and forty dollars.

UNIV. OF MICH.
29 APR 1896

AN IMPORTANT ELM INSECT.

NEVADA STATE UNIVERSITY.

Agricultural Experiment Station.

BULLETIN NO. 28.

RENO, NEVADA, NOVEMBER, 1895.

Agricultural Experiment Station

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THE DIRECTOR,
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Reno, Washoe County, Nevada.

WHEAT—Cutting at Different Dates.

R. H. McDowell.

Farmers have long recognized the fact that it is better to begin cutting grain one day early rather than one day late. The machinery is not always in perfect adjustment, and at this stage of growth the ripening advances rapidly every twenty-four hours.

Cutting grain at the right time is an important item in the final result. Extreme early cutting means loss from shrinking, while undue delay will result—with a possible exception of an occasional variety—in loss from shelling. After the farmer has met all the aequirements for a profitable crop, it is very desirable that he select the right date for cutting.

The variety used in two years trial is known as Gypsum; the kernel is of medium size In cutting the sample bundles, one bundle was cut and labeled at the same hour each day and placed in the second story of the tool-house—a well-ventilated building—and spread out to dry. When the last bundle was dry the entire lot was threshed, and the grain from each cutting was placed in a separate labeled sack. In determining the yield for each cutting, and from this the yield per acre, one-half ounce of grain was carefully weighed and the number of kernels counted a sufficient number of times to obtain the correct number of grains for one-half ounce. The cutting that required the least number of kernels to weigh one-half ounce (8-18 for 1894, and 7-23 for 1895) was taken as the one giving the best yield. In each case it was assumed that the maximum yield per acre was 40 bushels (our wheat, for five years, has yielded from 24 to 47 bushels per acre), and this was used as a basis for determining the yields of the other cuttings.

In cleaning wheat for determining the yield at the different stages of growth, all refuse material was removed, but no grain was screened out because not well matured.

Samples for 1894—Table No. 1—were cut from grain sown on April 23d; samples for 1895—Table No. 2—were taken from grain sown on October 19, 1894.

Notes on the condition of the grain and straw were taken daily during the progress cf cutting, and will be found following each table.

Table No. 1—WHEAT—1894.

DATE OF CUTTING.	No. Kernels in half ounce	YIELD PER ACRE.		
		Bushels.	Lbs.	Ozs.
8-7	662	24	24	10
8-8	580	27	51	13
8-9	517	31	15	7
8-10	466	34	40	10
8-11	460	35	7	13
8-12	414	39	2	..
8-13	422	38	17	10
8-14	411	39	19	2
8-15	406	39	21	12
8-16	424	38	6	12
8-17	411	39	19	2
8-18	404	40	..	..
8-19	409	39	30	10
8-20	425	38	1	6

8-7—Straw, green; grain. in milk.

8-8—Straw. still green. commencing to turn yellow; grain, still in milk, firmer.

8-9—Grain, soft dough; straw, mostly yellow with a tinge of green.

8-10—Grain, milk to medium dough; straw, pliable.

8-11—Some of the grain difficult to break; straw will answer for binding, portion brittle.

8-12—Some heads bending, portion of grain floury, remainder stiff dough; portion of straw still pliable.

8-13—Grain, very stiff dough; portion of straw pliable; for field work, ripe enough to commence cutting.

8-14—Grain, about 95 per cent. hard dough, difficult to break with fingers

8-15—Grain, still hard dough; straw, begins to break.

8-16—Grain. shells easily; straw, can be used for binding, although a portion is quite brittle.

8-17—Straw, very dry, rattles in handling; grain but little change since 8-16.

8-18—Straw, quite harsh. about the same general appearance as 8-17; grain, very few kernels can be broken.

8-19—Grain, fully dead ripe, shells easily; straw, as a rule, very dry; occasional straws still pliable.

8-20—Grain, wind shelling to some extent; straw, over ripe, and is used for bands with difficulty.

Table No. 2—WHEAT—1895.

DATE OF CUTTING.	No. Kernels in half ounce..........	YIELD PER ACRE.		
		Bushels.	Lbs.....	Ozs.....
7-13	486	31	47	12
7-14	478	32	19	12
7-15	483	31	59	12
7-16	467	33	5	7
7-17	435	35	31	8
7-18	426	36	16	8
7-19	411	37	35	15
7-20	414	37	19	10
7-21	405	38	9	6
7-22	405	38	9	6
7-23	386	40	..	..
7-24	398	38	49	10
7-25	401	38	32	3

7-13—Grain, in milk; straw, green and tough.

7-14—Grain, between milk and soft dough; straw, practically the same as 7-13.

7-15—Grain, riper, portion stiff dough; kernels turning yellow.

7-16—About 65 per cent. of grain stiff dough; 55 per cent. of straw yellow.

7-17—Most of grain stiff dough; straw 75 per cent. yellow, ripening rapidly.

7-18—Grain and straw mainly same condition as 7-17.

7-19—Grain, about 5 per cent. still in milk; straw, about 9-10 ripe.

7-20—Grain, most advanced, medium hard.

7-21—For field work, practically ripe, at least sufficiently so to begin cutting.

7-22—Straw, pliable at top, ripe at base; grain, quite hard.

7-23—Straw, does well for binding; grain, 50 per cent. very hard and shells easily.

7-24—Grain and straw dead ripe; straw breaks.

7-25—Grain appears hard enough for grinding; straw very brittle.

For the chemical portion of this Bulletin—Table No. 3—I am indebted to Prof. N. E. Wilson.

Table No. 3.

1894.				1895.			
GYPSUM.	Albuminoids	Crude Fiber.	Ash.	GYPSUM.	Albuminoids	Crude Fiber.	Ash.
1st Cutting....	12.46	2.425	1.9135	1st Cutting....	12.44	2.050	2.1135
2d Cutting....	11.21	1.9118	1.7385	2d Cutting....	8.58	1.250	1.9885
3d Cutting....	7.98	1.6500	1.6885	3d Cutting....	8.58	1.960	1.8635
4th Cutting....	7.55	3.250	1.7385	4th Cutting....	7.98	1.975	1.9135
5th Cutting....	9.18	2.600	1.4885	5th Cutting....	7.98	2.000	1.7385
6th Cutting....	9.18	2.550	1.3635	6th Cutting....	10.52	1.975	1.7635
7th Cutting....	8.58	2.520	1.7635	7th Cutting....	7.98	1.325	2.0885
8th Cutting....	8.85	2.300	1.6385	8th Cutting....	8.85	1.7700	1.9385
9th Cutting....	9.18	2.155	1.7885	9th Cutting....	9.18	1.8000	1.8135
10th Cutting....	10.52	2.000	1.6885	10th Cutting....	10.52	1.7000	1.8635
11th Cutting....	7.54	1.990	1.6135	11th Cutting....	9.18	1.375	1.9635
12th Cutting....	7.54	2.200	1.7885	12th Cutting....	9.18	1.650	1.8885
13th Cutting....	7.54	2.275	1.9135	13th Cutting ...	8.58	1.973	1.9635
14th Cutting....	8.58	2.150	1.5885	....	......	......	......

—Results in air dry substance.

DEFINITION OF TERMS.

Dry matter is that part of fodder left after the water has all been driven off. It is composed of two parts: (1) mineral matter or ash, the part left on ignition and which is principally the bone-forming material of the fodder; (2) organic matter, which is the part of the fodder destroyed by ignition.

The albuminoids contain on an average about 16 per cent. of nitrogen. In chemical analyses total nitrogen and albuminoid nitrogen are determined; the total nitrogen multiplied by 6.25 $(=\frac{100}{16})$ equals crude protein, and albuminoid nitrogen multiplied by 6.25 equals albuminoids; the difference gives amides.

Crude fiber, or cellulose, is the framework of plants, forming the walls of their cells. Usually it is the least digestible portion of plants. It is determined, in the laboratory, by dissolving out all parts of the fodder by means of boiling out in weak acid and alkali solutions successively.

D. S. Curtiss says in "Wheat Culture:" "An English farmer reports cutting three lots of wheat at different stages of maturity—in the milk, in the dough, and fully ripe. He threshed separately, and had one hundred pounds of each carefully ground and the results weighed.

AMOUNT.	FLOUR.	SHORTS.	BRAN.
100 pounds—cut in the milk.........	75 pounds..	11 pounds..	12 pounds..
100 pounds—cut in dough...........	80 pounds..	5 pounds..	13 pounds..
100 pounds—cut fully ripe.	75 pounds..	11 pounds..	15 pounds..

"Two pounds lost in milling in each case. This shows the dough state made the most flour, and the ripest made the least flour and most bran."

Mr. Reid of Indiana, reports to the Agricultural Department that he cut half a fifty-acre field of Mediterranean wheat in the dough state and the balance ten days later The first gave the most bushels and weighed 65 pounds; the last, less bushels, weighing only 60 pounds; the first also made more and better flour. For flour and milling purposes wheat cut early is the best, but the small quantity needed for seed should stand until perfectly ripe.

SUMMARY.

1 —For 1894 the yield was best for August 18th, or the 12th cutting, the notes reading for this date: "Straw, quite harsh, rattles in handling; grain, shells easily." Farmers will agree with me in saying that although the yield is slightly greater, it will not answer to allow grain to get to this stage of ripening before cutting, as there will be too much loss from shelling.

2.—From the 12th to the 15th of August for 1894 is suggested as the best date for cutting—with the grain in stiff dough and the yield nearly to the maximum. For 1895, 7-21 is suggested for cutting date.

3.—Straw for feeding purposes is much more valuable if not over ripe. Dr. Kedzie says in Bulletin 101, "that in the earlier stages of growth the straw compares favorably with hay; but at later stages of growth its value diminishes rapidly, especially when we remember that the old and consolidated crude fiber is less digestible."

TEXAS CATTLE FEVER.

NEVADA STATE UNIVERSITY.

Agricultural Experiment Station.

BULLETIN NO. 31.

RENO, NEVADA, DECEMBER, 1895.

Agricultural Experiment Station.

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THE DIRECTOR,

Agricultural Experiment Station,

Reno, Washoe County, Nevada.

TEXAS CATTLE FEVER.

By W. McN. Miller, B. Sc., M. D.

In September of 1894 the following newspaper bullettin on "Texas Cattle Fever" was submitted to the Press of Nevada. Its length exceeded the capacity of most local newspapers and consequently a very limited circulation of the bulletin throughout the State was obtained. Because of this fact and because of the general interest in the subject aroused by the placing of an official cattle inspector at Reno to represent the Bureau of Animal Industry of the United States Department of Agriculture, for the purpose of inspecting cattle coming from the State of California, it has been decided to publish it anew, together with other matter pertaining to the subject, as a regular Station bulletin.

TEXAS CATTLE FEVER.

On the evening of September 9th the attention of the writer was called to an epidemic disease prevailing amongst the milch cows on the ranch of Mr. Morris Cohn in Carson Valley, Douglas County. On the twelfth of the month and on the fifteenth and sixteenth, visits were made to the herd, which had been removed to the State line at the south end of Lake Tahoe. Autopsies were held on several animals and subsequently microscopic examinations were made of the blood and other tissues. The results attained, together with a careful study of the symptoms, led to the diagnosis of Southern Cattle Fever, or Texas Fever. There was no doubt as to the accuracy of the diagnosis, all facts pointing directly to that disease. It will not be the purpose of this article to go deeply into the history of the outbreak nor to give an extended account of the various features of the disease. The objects of the papers will be (1) to review briefly the history of the epidemic; (2) to give the characteristics of the disease; (3) to discuss its cause and means of dissemination; (4) to state briefly the leading features of the disease; (5) to announce the treatment recommended, and (6) to relate the measures to be adopted to prevent its future establishment in the State.

HISTORY OF THE EPIDEMIC.

In June, 1894, Mr. Cohn imported from San Louis Obispo, California, four hundred head of milch cows apparently in excellent condition, excepting possibly a single animal, which one gave some evidence of the disease, and placed them in a pasture with a herd of one hundred and sixty-eight healthy native cows. In the month of July a few of the native cows became sick and died. In the month of August more cows and in greater number, also sickened and died and up to September sixteenth but forty four of the original one hundred and sixty-eight native cattle remained alive. At that date they were dying at the rate of seven or eight a day and a goodly proportion of those remaining were afflicted with the fatal illness. Being fine milch cows, it is not on extravagant estimate to place the loss at four thousand dollars. It is interesting and important to note at this point that not one of the imported California cows took sick and died. This fact in itself, when definitely ascertained, was almost sufficient evidence to establish the diagnosis of Texas fever.

THE DISEASE DEFINED.

As defined by Drs. Salmon and Smith of the Bureau of Animal Industry, Department of Agriculture, Washington, D. C., Texas fever is a specific fever communicated by cattle which have been recently moved northward from the infected district, or which is contracted by cattle taken into the infected district from other parts of the world. It is characterized by the peculiarity that animals which disseminate the affection are apparently in good health, while those which sicken and die from it do not, as a rule, infect others.

It is accompanied by high fever, greatly enlarged spleen, destruction of the red blood corpuscles, escape of the coloring matter of the blood through the kidneys, giving the urine a deep red color, by yellowness of the mucus membranes and fat, which is seen more especially in fat cattle, by the rapid loss of strength, and by fatal results in a large proportion of the cases.

So far as the writer has been able to find, this summer marks the first introduction of the disease into the State. In the past, great losses have been experienced in the Western States lying to the east of Nevada, the disease being introduced by the driving of Southern cattle through them; but in more recent years the losses have been greatly diminished by regulations governing the movement of Southern cattle, as issued yearly by the Secretary of Agriculture.

CAUSE AND MEANS OF DISSEMINATION.

It is claimed by Drs. Salmon and Smith that the disease is due to the action of a parasitic protozoan, a microscropic animal of the lowest type and not exceeding one twenty-thousandth of an inch in diameter. which lives within and ultimately destroys the red corpuscles of the blood. The blood corpuscles are destroyed in immense numbers, and great quantities of waste products are found in the blood, which tax the organs of excretion to their utmost limit to get rid of them, failing in the large majority of cases. The further and special consideration of the results will be referred to below.

A further interesting feature of the disease is the means for its dissemination. Results of experiments, conducted under the direction of the above mentioned gentlemen, has led them to announce that its usual mode of dissemination is through the mediation of a cattle tick, found parasitic upon cattle of the Southern States. Its usual sites for attaching itself for the purpose of drawing blood from the cattle are the thighs, escutcheon and udder, places where the skin is thin and usually protected.

Cattle imported from permanently infected districts carry these ticks. When matured the female tick falls to the ground, lays a large number of eggs, which hatch, infect the pasture and through attachment to native cattle, disseminate the disease. The time required for the various steps of development of a new brood of ticks from those brought in by imported cattle, for their attachment and for the development of the disease, varies from thirty to ninety days. As freezing weather impairs the vitality of the ticks and ultimately kills them, it will be easily understood that no great extension of the disease will occur beyond herds which are now infected.

It is quite probable that there are herds of cattle within the State which have been exposed to infected pastures, corrals, roadsides or cattle cars, which have not yet given evidence of their infection. For this reason it would be well for all cattle raisers of the State, who suspect any contamination, to inspect their herds for cattle ticks, and if found, to proceed with the preventive treatment recommended below. The coming winter will probably kill all the ticks and there needs be little fear concerning an outbreak of the disease in the following summer, provided no cattle are imported from California or other infected districts after the freezing weather is over.

SYMPTOMS AND PATHOLOGICAL CONDITIONS.

As shown by the cattle inspected and examined at the State line, the chief symptoms and pathological conditions were as follows: The disease first manifests itself by fever, dullness, diminished quantity of milk in cows, loss of appetite and a tendency to leave the herd. The temperature varies from 104 degrees Fahrenheit to as high as 107.6 degrees. The higher the fever the sooner comes the fatal end. The bowels are usually constipated, but towards the end of the course of the disease the dung becomes softer and yellow from the contained bile. The urine is passed frequently in considerable quantities and finally, as the end approaches, becomes dark red from the contained blood coloring matter. The pulse and respiration are rapid, and as the end approaches the muscles quiver, the animal becomes unable to stand, falls, and usually dies in convulsions. Infected animals usually die after from three days to several weeks of illness, depending upon the severity of the disease and the height of the fever. Animals which survive the disease recover slowly and require many weeks to regain their flesh.

The pathological conditions closely resemble those of anthrax, showing it to be a blood disease. A microscopic examination of the blood easily discriminates the one disease from the other. In anthrax the blood plasma, or fluid, is thickly crowded with the bacilli which cause the disease. These bacilli are rod-shaped organisms and are plants. In Texas fever, as stated above, the parasitic protozoa are animals.

The blood is thin, watery and dark in color. The spleen, or milt, is greatly enlarged, dark, and on cutting it open is found to be black, soft and without its normal markings. The liver is enlarged, yellow internally, instead of brown and mottled. The gall bladder is greatly enlarged, the contents are yellow and contain many flakes, giving the bile the consistency of well cooked sago soup. The kidneys are deeply colored from the coloring matter of the blood, and in the bladder there is found a quantity of urine, the color of which resembles port wine or claret. Usually the fat about the kidneys and all the abdominal viscera are stained yellow from the coloring matter of the bile. Less important and varying pathological conditions of the viscera are found. The heart frequently shows extravization of blood, but the lungs are usually normal.

A most important thing to notice is the presence of cattle ticks, which are rarely seen on native cattle not infected with this disease.

TREATMENT.

The treatment is of a two-fold nature, viz: First, for the prevention, and second, for the curing of the disease when once developed.

Upon the assumption that the disease is dependent upon a parasitic protozoan and upon the basis of the modern treatment of malarial fever in the human, a disease likewise dependent upon such a parasite, quinine sulphate was recommended in large doses, both for the prevention of the disease and its cure. The treatment recommended is experimental, but in the lack of definite and satisfactory results from other and older methods it was deemed advisable to give it a trial.

Preventive treatment embraces, first, the removal of the affected herd, sick as well as healthy animals, to new and non-infected pastures; second, the destruction of the ticks by currying, collecting and burning and by the application of insecticides to the parts of the animals infested with the ticks; third, and as indicated above, the administration of quinine sulphate.

To prevent the development of the disease it was recommended that animals infested with the ticks be washed once a week on parts exposed to the action of the ticks with a kerosene oil emulsion prepared after the following manner: (This was done on the advice of Professor F. H. Hillman, Entomologist of the Nevada Experiment Station.)

To one gallon of water add one pound of common laundry soap and dissolve by boiling. Remove from the fire and immediately, at a safe distance, add two gallons of common kerosene oil. Mix thoroughly by the use of a horse syringe, spray pump or other instrument for violent agitation, till the whole becomes a creamy, frothy mass. If on standing and cooling the oil rises to the top, the heating and mixing process will have to be repeated. To one pint of the emulsion as thus prepared, add four gallons of cold water and stir. With this last mixture the parts infested with cattle ticks are washed. Results from this treatment depend entirely upon how faithfully and fully it is carried out.

Quinine sulphate as a preventive medicine was recommended in doses of thirty grains daily. It should be moistened with an ounce (two tablespoonfuls) of alcohol, and then added to a pint of water, drenching.

To cure the developed disease it was recommended that the temperature of all animals of the herd be taken systematically with an ordinary physician's clinical thermometer, and to those whose temperature exceeds 103 degrees Fahrenheit there be given 150 grains of quinine sulphate after the manner indicated above. This was to be followed by doses of thirty grains daily till the temperature was reduced to normal—from 100 degrees to 102 degrees Fahrenheit. In the lack of a thermometer the earliest symptoms—dullness, loss of appetite, etc.—might be taken as an indication for the active treatment. Men handling these cattle quickly learn to distinguish the affected animals. In addition to this quinine treatment attention should be given to the destruction of the ticks as indicated above.

MEASURES TO PREVENT ITS INTRODUCTION INTO THE STATE.

The means for the prevention of the future establishment of the disease in the State now demands consideration. From the conclusions stated above concerning the means of dissemination of the disease, it is clear that to prevent its introduction, cattle should not be imported into the State from infected districts except in freezing weather. The time limits established by the Secretary of Agriculture for the Northern States, in which Southern cattle may be imported, are from December 1st to February 15th. The climate of our State, especially in the northern portion, is not unlike that of the Eastern and Northern States, and the time limits for the importation of cattle may be safely adopted here. At this point it will be well to say to cattle raisers of nervous temperament that unless your herds have been exposed in a manner indicated above, or unless your pastures have become infected through overflow of water from neighboring infected pastures, there is little probability of the disease appearing amongst your cattle. However and repeating, it would be wise to inspect your herds for cattle ticks.

Since the preparation of the above, information comes to hand through the *Elko Independent* of an immense loss of cattle in the eastern part of the State through which a herd of cattle imported from California had been driven. From the information contained in the article, and in connection with the facts related above, the writer has no hesitation in confirming the diagnosis of the *Independent*, *i. e.*, Texas fever.

Finally, the writer strongly recommends the enforcement of regulations governing the movement of California cattle in the State. This may be arrived at by the extension of the regulations of the Department of Agriculture, or by the enactment of proper regulation by the Legislature of the State.

In closing, the writer wishes to state his obligations to Drs. Salmon and Smith, from whose excellent paper on this subject he has had no hesitation to take what he would.

W. McN. MILLER,

Special Investigator of Diseases of Animals, Nevada Agricultural Experiment Station.

RENO, Nevada, September 22, 1894.

Extracts From a Bulletin on "Texas Fever in California," Published by the State of California.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
WASHINGTON, D. C., April 24, 1896.

HON. J. STERLING MORTON, *Secretary of Agriculture:*

SIR: As requested by you, I submit the following report covering the most important information in the possession of this Department concerning the existence of the disease known as Texas fever in California. This disease is also known, and is referred to in quotations made below, as Southern fever, Splenic fever, Splenetic fever and Spanish fever.

* * * * * * * * *

The question of cattle disease in California was not again brought to the attention of the Department until 1894. During that year it was alleged that outbreaks of Texas fever had occurred in Nevada, Kansas, and Missouri, from California cattle taken to those States. The following is from a report of Mr. Albert Dean, who is stationed at the Kansas City Stock Yards, and has charge of the inspection of cattle from the Texas fever district:

"From February 1 to November 20, 1894, 127,388 cattle were shipped from the native divisions of the Kansas City Stock Yards to points in the State of Kansas, for grazing and feeding, and during the same period of time 116,691 head of feed and stock cattle were shipped from the same yards to points in the State of Missouri. From this movement, aggregating 244,079 cattle, an outbreak of Southern cattle fever occurred on the farm of J. R. Blackwell, Lees Summit, Jackson County, Missouri, and also the same disease developed on the farm of O'Donnell & Son, Gridley, Coffee County, Kansas. Both of the above named parties, on June 5, 1894, bought cattle in the Kansas City Stock Yards that had been received that day from Ventura, California, and took them to their farms."

On account of these outbreaks of disease, apparently caused by California cattle, Mr. W. E. Hill, an inspector of this Bureau, was directed to proceed to California and make an investigation as to the extent of territory in that State which is permanently infected with the Texas fever contagion. In the years intervening between 1886 and 1894 the investigations of this Bureau had done very much to clear up the mysteries surrounding this disease. It was shown that the contagion was disseminated by the cattle-tick known as the *Boophilus bovis*, and that the distribution of this tick in the eastern part of the United States corresponded with the district permanently infected with Texas fever. In other words, cattle coming from sections where this tick existed would spread Texas fever, and those coming from sections where the tick did not exist were found to be harmeless. Mr. Hill's reports, from which I shall quote extensively, are, therefore, largely given up to a determination of the districts in California in which the cattle-tick, *Boophilus bovis*, is found, although he has also presented evidence to show that the cattle in these districts disseminated Texas fever in exactly the same manner as do the cattle from the tick districts of the States bordering on the Atlantic and Gulf coasts.

* * * * * * * * *

The information which is given above is certainly sufficient to show that a large area of territory in California is permanently infected with Texas fever. Many cattle have undoubtedly died from the disease in that State. The cattle-tick, which disseminates the contagion, is found in abundance there, and outbreaks of the disease have been caused in other States by California cattle. The limits of the infected area in that State have not been accurately détermined, and further investigation will be required to enable any one to make a line separating the infected from the non-infected territory. With a large movement of cattle from California to other States, it is necessary to have regulations which will prevent the dissemination of disease with certainty, and the Department can only consistently make the same regulations apply in the same manner to California as they apply to other States for a like purpose.

Very respectfully,

D. E. SALMON,

Chief of Bureau.

REGULATIONS CONCERNING CATTLE TRANSPORTATION.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
WASHINGTON, D. C., February 1, 1896.

To the Managers and Agents of Railroads and Transportation Companies of the United States, Stockmen and Others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An Act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and of the act of Congress approved March 2. 1895, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1896, you are hereby notified that a contagious and infectious disease known as splenetic or Southern fever exists among cattle in the following-described area:

All that country lying south, or below, a line beginning at the northwest corner of the State of California, thence east, south and southeasterly along the boundary line of said State of California to the southeastern corner of said State, thence southerly along the western boundary line of Arizona to the southwestern corner of Arizona, thence along the southern boundary lines of Arizona and New Mexico to the southeastern corner of New Mexico. thence northerly along the eastern boundary of New Mexico to the southern line of the State of Colorado, thence along the southern boundary lines of Colorado and Kansas to the southeastern corner of Kansas, thence southerly along the western boundary line of Missouri to the southwestern corner of Missouri, thence easterly along the southern boundary line of Missouri to the Mississippi River, thence southerly along the Mississippi River to the southern boundary line of Tennessee, thence easterly along said boundary line to the southeastern corner of Polk county, Tennessee, thence northerly along the eastern boundary line of Tennessee to the southern boundary line of Virginia, thence west along said boundary line to the boundary line of Kentucky at the western point of Virginia, thence northerly along said boundary line to the northernmost point of Virginia, thence southerly along said boundary line to the northeast corner of Virginia where it joins the southeastern corner of Maryland, at the Atlantic Ocean.

Whenever any State or Territory located above or below said quarantine line as above designated shall duly establish a different quarantine line, and obtain the necessary legislation to enforce said last mentioned line strictly and completely within the boundaries of said State or Territory, and said last above mentioned line and the measures taken to enforce it are satisfactory to the Secretary of Agriculture, he may by a special order temporarily adopt said State or Territorial line.

Said adoption will apply only to that portion of said line specified, and may cease at any time the Secretary may deem it best for the interest involved, and in no instance shall said modification exist longer than the period specified in said special order; and at the expiration of such time said quarantine line shall revert without further order to the line first above described.

Whenever any State or Territory shall establish a quarantine line, for above purposes, differently located from the above described line, and shall obtain by legislation the necessary laws to enforce same completely and strictly, and shall desire a modification of the Federal quarantine line to agree with such State or Territorial line, the proper authorities of such State or Territory shall forward to the Secretary of Ariculture a true map or description of such line and a copy of the laws for enforcement of same, duly authenticated and certified.

Such States or Territories as now have a line established as last above mentioned can immediately forward certified copies of said line and laws for the enforcement thereof, and if satisfactory to the Secretary of Agriculture, the same may be adopted at once and the Federal line so modified.

From the 15th day of February to the 15th day of November during each year no cattle are to be transported from said area south or below said Federal quarantine line above described to any portion of the United States above, north or west of the above described line, except by rail for immediate slaughter, and when so transported the following regulations must be observed:

1. When any cattle in course of transportation from said area are unloaded above, north or west of this line to be fed or watered, the places where said cattle are to be fed or watered shall be set apart and no other cattle shall be admitted thereto.

2. On unloading said cattle at their points of destination, pens shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of cattle from said area, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars that have carried said stock shall be cleansed and disinfected before they are again used to transport, store, or shelter animals or merchandise.

3. All cars carrying cattle from said area shall bear placards stating that said cars contain Southern cattle, and each of the waybills of said shipment shall have a note upon its face with a similar statement. Whenever any cattle have come from said area and shall be reshipped from any point at which they have been unloaded to other points of destination, the cars carrying said animals shall bear similar placards with like statements, and the waybills be so stamped. At whatever point these cattle are unloaded they must be placed in separate pens, to which no other cattle shall be admitted.

4. The cars and boats used to transport such animals, and the pens in which they are fed and watered, and the pens set apart for their reception at points of destination, shall be disinfected in the following manner:

(*a*). Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime or saturating it with a 5 per cent solution of carbolic acid, or, if not disinfected, it may be stored where no cattle can come into contact with it until after November 15.

(*b*). Wash the cars and the feeding and watering troughs with water until clean.

(*c*). Saturate the walls and floors of the cars, and fencing, troughs and chutes of the pens with a solution made by dissolving 4 ounces of chloride of lime to each gallon of water. Or disinfect the cars with a jet of steam under a pressure of not less than 50 pounds to the square inch.

Cattle from the Republic of Mexico may be admitted into the United States to remain below said Federal quarantine line after inspection according to law, but said cattle shall not be permitted to cross said quarantine line otherwise than by rail for immediate slaughter, except by special permit from the inspectors of the Bureau of Animal Industry issued according to the regulations of the said Bureau, and no permit shall be issued except for cattle free from splenetic or Texas fever, or from contact therewith during the three months preceding the issuance of said permit, and which have been grazed in a locality free from infection of such fever.

The losses which formerly occurred to the owners of susceptible cattle, both in the interstate and export trade, by the contraction of this disease from exposure in unclean and infected cars and pens, and by means of the manure carried in unclean cars from place to place, became a matter of grave and serious concern to the cattle industry of the United States until this danger was removed by the inspection of this Department. It is absolutely essential, therefore, that this cattle industry should continue to be protected as far as possible by separating the dangerous cattle and by the adoption of efficient methods of disinfection.

Inspectors will be instructed to see that disinfection is properly done, and it is expected that transportation campanies will promptly put into operation the above methods.

All prior orders conflicting herewith are hereby revoked.

J. STERLING MORTON,
Secretary.

SAMPLING FOR ANALYSIS.

NEVADA STATE UNIVERSITY.

Agricultural Experiment Station.

BULLETIN NO. 32.

RENO, NEVADA, DECEMBER, 1896.

Agricultural Experiment Station.

NEVADA STATE UNIVERSITY.

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Address all communications to

THE DIRECTOR,
AGRICULTURAL EXPERIMENT STATION,
Reno, Washoe County, Nevada.

DRINKING WATER.

BY N. E. WILSON.

With reference to its use for town and domestic purposes water may be roughly divided into:

Rain water; surface water, including streams and ponds; ground water, including shallow wells; deep-seated water, including deep wells, artesian wells and springs, each of which has its peculiar properties.

A water containing a large amount of dissolved substances—so that it can be properly designated as a "mineral water," would not be adopted for a town or city supply, nor, for that matter, be used as a general beverage, except for its medicinal effect—real or fancied.

A small amount of mineral matter is usually beneficial. The presence of such substances, however, is not necessary; a fact which is abundantly proved by the wholesome effect of drinking distilled water on shipboard.

It is contended by some that the human system needs salts of lime, etc., and that these salts are supplied in an assimilable form in water, and that consequently a somewhat hard* water is advantageous for a town supply. It is, however, the result of general observation that a water whose hardness is due to sulphate of lime and magnesium salts, is not suitable for drinking purposes, and, in fact, is really injurious to most persons.

Waters, especially surface waters, containing much vegetable matter, are in most cases unwholesome. Water polluted by waste materials from factories and sewerage from towns and houses is certainly most unwholesome, and frequently is the cause of certain specific diseases.

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*By hard water is generally meant water containing large amounts of salts of lime and magnesium.

Authorities are divided on the question of unwholesomeness of water. Some claim that water carrying even large amounts of organic matter or even sewerage does not of itself cause disease, but that disease is caused by *germs* or *bacteria*. This view is known as the "Germ theory" of disease. But others cling to the older theory that polluted water can, and does, cause disease.

Some supporters of the "Germ theory" go so far as to claim that germs which enter the stomach in drinking water do no harm as they are rendered harmless by the fluids of the stomach, so that drinking waters are not to be considered at all as a means of carrying the germs of disease. Although it is true that the drinking water theory has not been proved, in the sense in which a mathematical proposition can be proved, the coincidences, if they be coincidences, are extremely remarkable, and each season adds to their number. That contaminated water *is* a means of conveying disease of the most malignant type, though possibly not "proven" in a mathematical sense, is very highly probable. And taking into consideration the fact that bacteria are found in drinking water, and that the organic matter contained in water is a "culture medium" for such bacteria, it is an assured fact that water is a carrier of germs, and as such is responsible for a large amount of disease.

One of the most striking instances, and one going far towards proving the above theory is the "Maplewood Female Seminary case."

The house was a large, wooden structure, closely surrounded by trees, with a foul barnyard in close proximity. In this barnyard was stagnant water in which swine wallowed. The kitchen drain opened about ninety feet from the house. All this filth soaked into the ground and soon found its way into the veins supplying the wells from which the table water was taken. The water thus contaminated must have become a vast nursery for the germs of disease. Out of seventy-four resident pupils, sixty-six (90 per cent) were taken sick. Of these fifty-one had well marked cases of typhoid fever. Out of the whole number of scholars (112) fifty-six had typhoid fever and of this number sixteen died.

An outbreak of typhoid fever at St. Mary's Hall in Burlington, N. J., led to an investigation which disclosed a sanitary condition full worse than that which existed at "Maplewood." It was found that the water supply was from two rainwater cisterns, in building which, as their bottoms were below the level of the soil water, a hole was left open to relieve the pressure while the cement was hardening. These holes were then plugged and the water supply was taken from the river. One year later these plugs were removed, thus bringing the cisterns into communication with the soil water. The water became contaminated and fever broke out. The use of this water was abandoned, the river water being used exclusively. In ten days the fever disappeared and the school has been free from all such diseases ever since, some eighteen years now. While six out of seven of the pupils had the fever, none of the servants were attacked. This is accounted for by the fact that while the pupils drank the water in an unboiled condition the servants used it only in tea and coffee.

Another remarkable example* is the case of a typhoid fever outbreak in North Boston, N. Y., in 1843. This case occurred before the connection between typhoid fever and drinking water was a theory.

This community consisted of nine families (forty-three persons) and typhoid fever had never before been known in the vicinity. During this year (1843) a sick traveler took lodging at the tavern and twenty eight days thereafter died, of what was pronounced by the physicians to be typhoid fever. The disease spread; twenty-eight in all were attacked, and only three families escaped. These three families were the only ones who did not use the water from the tavern well; two of them on account of distance and one on account of a fued between them and the inn keeper. This family lived only forty rods from the tavern. The physician, at the time, ascribed the communication of the disease to a "contagium contained in the emanations from the body," but the people charged the family referred to *with poisoning the well*, so remarkable was the coincidence, Subsequently Dr. Austin Flint, in reviewing the case, regards it as "*vastly probable, if not certain*" that the disease was communicated by the drinking water, the source of which was so situated that it must have been contaminated from the dejections of the first patient.

In this section of the country, where so few deep wells exist and where we are almost entirely dependent on surface water for our supply, it is this class of water which most naturally interests us.

No surface water is free from vegetable and animal life. It is seldom, however, that any trouble arises from this cause when the water is taken directly from running streams, but the water in lakes and ponds and in storage reservoirs is very liable to be disagreeably affected by the growth and decay of animal, and more especially of vegetable organisms. The presence of fish in a source of water supply is rather an advantage than otherwise; however cases arise in which for various causes a large number of fish die, consequently the sources of supply must be watched and the dead fishes carefully removed. Other forms of animal life are abundant, but are harmless and are easily removed by even the simplest forms of filtration. One peculiar form of animal life—spongilla—or fresh water sponge, is often the cause, by decaying, of badly polluted water.

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*Nichols' Water Supply, p 22.

Of plant life found in water supplies, it may be said. in general, the following aquatic plants, such as are commonly known as ell-gross, pond weed, etc., are in themselves of no disadvantage *while growing*. When decaying, however, in a limited volume of water, they produce a bad taste and odor. The plants which give the most trouble are the non-flowering plants *(cryptogams)*, and of the particular class called *algae*. These algae, when present in any considerable quantity, give a repulsive appearance to the water, and by decaying impart an offensive taste and odor. Their presence is not really a sign of pollution, but it is a fact that they thrive best in waters containing mud and vegetable extractive matters.

ACTION OF FRESH WATER UPON VEGETABLE MATTER.

When vegetable matter decays in moist soils, it is converted into a brown or black substance generally known as *humus*; this is really a mixture of several different bodies, and from it chemists have isolated a variety of substances, such as humic acid and humin ulmic acid and ulmin. The acids of humus, by oxidation, undergo chemical changes and form salts which are found in surface waters, but when vegetable matter is thoroughly humified, as in the case of peat, it exerts no bad effect on water except to give it a brown color and an earthy taste. When a recently felled tree is exposed to the action of water, or when bushes or even grass and weeds are killed by flooding, the sap and more soluble matters are leached out and putrify, or in the presence of air undergo other forms of decomposition. This action will take place, no matter under what depth the vegetable matter may be placed, but the effect will be less as the amount and motion of the water is greater. After the more soluble portions are extracted, the subsequent decay proceeds with extreme slowness, provided the remaining portions are kept continually covered with water, but alternate exposure to air and water soon cause decay. In a natural or artificial reservoir, the inevitable variations of level are very disadvantageous. As the level is lowered the aquatic plants die, and if the water rise after a short interval it becomes impregnated with the products of their decay. If a considerable interval elapses, land plants grow upon the exposed places, and being drowned by the rising waters, tend to contaminate in the same manner. It appears from this, that in the construction of impounding reservoirs, the moss of growing plants as well as the soil in which they have roots and which of itself contains more or less soluble organic matter, should be removed as thoroughly as possible.

A peculiar condition exists in irrigation countries that naturally affects both wells receiving surface water and streams; that is the large amount of waste water from irrigating, which, in passing over and through the soil abstracts large quantities of organic and other matter, thence finding its way into wells and and streams tends to contaminate them. This is shown by the fact that such sources of water supply are purer in winter, when no irrigation is carried on, than in summer.

Many of the mountain waters of the west, though issuing from clefts in rocks, are, by the time they reach valleys, ladened to quite an extent with organic matter. This is caused by their flowing over dead or decaying vegetable matter on their way down the mountains.

*Dr. Smart, whose opinion is entitled to much weight, ascribes the "mountain fever" of the west to this cause. He says: "As animal matter, in certain stages of decomposition, or enveloping specific germs, gives expression to its presence in the system, by the development of typhoid fever, so vegetable matter in certain stages of decomposition or enveloping specific germs gives rise to an adynamic remittent, for which the writer has suggested the name of *aqua malarial fever*. Viewed in its connection with this affection, the organic ammonia should not exceed 0.016 part in 100,000, for when 0.020 is reached, the disease makes its appearance, and becomes more pernicious in individual cases as the amount increases. Not that aquamalarial developments are to be expected in every case where the organic ammonia exceeds this limit, but that experience shows a greater probability of their occurrence with a water thus impregnated—malaria being much more likely to be present with a large than a small vegetable contamination."

Undoubtedly the best water for drinking is a moderately soft spring water, in which all possibility of contamination is out of the question. Unfortunately, however, it is very seldom that such water is available in sufficient quantities to supply large towns. Many spring waters are so hard that, while suitable for drinking, they are totally unfit for many manufacturing purposes, for steam boilers and for washing and culinary purposes.

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*Nichols' WaterSupply p, 84-100.

The question has often been asked why a sample of water taken from one point in a city service is more contaminated than one from another, both coming from the same source. This question is answered in the main by the fact that in most city systems there are so called "Blind Ends" to the mains and which are so very seldom flushed, consequently there collects at these points a large amount of sediment, organic and otherwise, which is churned up there and a sample taken from near this end through a service pipe will necessarily be more contaminated than one taken further away.

ANALYSES OF WATERS FROM VARIOUS SOURCES.

Station No.	Source of Sample.	By Whom Given.	Postoffice Address.	Station No.
1001	Spring water	J. H. B. Harris	Silver Peak, Nevada	1001
1004	University reservoir	R Brown	Reno, Nevada	1004
1005	University reservoir	Tap in Station Laboratory	Reno, Nevada	1005
1006	Well water	Burke Bros., North Virginia street	Reno, Nevada	1006
1007	Well water	W. A. Cobb	Verdi, Nevada	1007
1008	Well water	Stanley house, north side Mill street	Reno, Nevada	1008
1010	Well water	J. H. Smart	Mason Valley, Nevada	1010
1011	Well water	Wells' ranch	Reno, Nevada	1011
1012	University supply	Tap in Station Laboratory	Reno, Nevada	1012
1013	University supply	Tap in Station Laboratory, Pasteur filter		1013
1018	Well water	W. R. James	Virginia City, Nevada	1018
1019	Well water	"Town pump"	Verdi, Nevada	1019
1020	Well water	Strassburg's Cigar Store, Virginia street	Reno, Nevada	1020
1021	City supply	W. O. H. Martin's store	Reno, Nevada	1021
1022	Well water	T. V. Julien	Reno, Nevada	1022
1024	Spring water	C. R. Carter	Verdi, Nevada	1024
1025	Spring water	C. R. Carter, after cleaning spring	Verdi, Nevada	1025
1026	Well water	Wm. Fogg	Reno, Nevada	1026
1027	Well water	P. A. Doyle	Carson City, Nevada	1027
1028	Small reservoir	City supply	Reno, Nevada	1028
1029	Large reservoir	City supply	Reno, Nevada	1029
1030	Flume entering reservoir	City supply	Reno, Nevada	1030
1031	Water from river opposite	C. H. Stoddard	Reno, Nevada	1031
1032	City supply	W. O H. Martin's store	Reno, Nevada	1032
1033	University supply	Tap in Station Laboratory	Reno, Nevada	1033
1034	University supply	Tap in Station Laboratory, Pasteur filter	Reno, Nevada	1034

ANALYSES OF WATERS FROM VARIOUS SOURCES—*Continued.*

Station No.	Source of Sample.	By Whom Given.	Postoffice Address.	Station No.
1035	Well water	Wm. Sanders, Sierra street	Reno, Nevada	1035
1037	Well water	Dr. W. H. Hood	Battle Mountain, Nevada	1037
1038	Well water	Nathan Stanley—Prof. Miller	Reno, Nevada	1038
1039	Well water	Chism's ranch	Reno, Nevada	1039
1040	Well water	C. H. Eaton's ranch	Reno, Nevada	1040
1041	Well water	R. Ryland's residence	Reno, Nevada	1041
1042	Well water	W. C. Gregory, well near slaughter house	Washoe City.	1042
1049	Well water	Miller ranch	Glendale, Nevada	1049
1052	Well water	Wm. Fogg	Reno, Nevada	1052
1054	Well water	James Agler	Wadsworth, Nevada	1054
1055	Well water	James Agler	Wadsworth, Nevada	1055
1058	Well water	J. H. Clark, Miller ranch	Glendale, Nevada	1058
1060	City water	Fletcher's building, Virginia street	Reno, Nevada	1060
1062	Well water	Dr. W. A. Phillips' residence	Reno, Nevada	1062
1063		A. C. Bragg	Reno, Nevada	1063
1064		A. C. Bragg	Reno, Nevada	1064
1065		A. C. Bragg	Reno, Nevada	1065
1066		A. C. Bragg	Reno, Nevada	1066
1067		A. C. Bragg	Reno, Nevada	1067
1068		A. C. Bragg	Reno, Nevada	1068
1072	Well water.	Section House, C. P. R. R.	Reno, Nevada	1072
1073	City water	J. A. White	Reno, Nevada	1073
1075	Well water	B. N. Curtis	Reno, Nevada	1075
1086	Well water	C. F. Fox	Yerington, Nevada	1086
1091	Well water	F. C. Pease	Reno, Nevada	1091
1095	Head of ditch	C. C. Powning	Reno, Nevada	1095

1096	Hunter Creek	C. C. Powning	Reno, Nevada	1096
1097	Receivers	C. C. Powning	Reno, Nevada	1097
1098	Reservoir	C. C. Powning	Reno, Nevada	1098
1099	Water marked No. 5.	C. C. Powning	Reno, Nevada	1099
1100	Water marked No. 6	C. C. Powning	Reno, Nevada	1100
1101	Water marked No. 7	C. C. Powning	Reno, Nevada	1101
1106	Spring water	Station Farm	Reno, Nevada	1106
1107	Water	C. C. Powning	Reno, Nevada	1107
1109	Water	C. C Powning	Reno, Nevada	1109
1110	Water	C. C. Powning	Reno, Nevada	1110
1111	Water	C C. Powning	Reno, Nevada	1111
1113	Well Water	M. Parrott	Reno, Nevada	1113
1115	Well water	F. J. McCullough	Carson, Nevada	1115
1116	Well water	M. Parrott	Reno, Nevada	1116
1117	Water from new water site	R. Ryland	Reno, Nevada	1117
1118	Water, not labeled	C. C. Powning	Reno, Nevada	1118
1119	Well water, Hood's well	Dr. W. H. Hood	Battle Mountain, Nevada	1119
1120	Water, Clancey's well	Dr. W. H. Hood	Battle Mountain, Nevada	1120
1121	Water, Licking's well	Dr. W. H. Hood	Battle Mountain, Nevada	1121
1122	Reservoir	J. N. Evans	Reno, Nevada	1122
1123	Well water	Strassburg's store	Reno, Nevada	1123
1124	Well water	Golden Eagle Hotel	Reno, Nevada	1124
1125	Well water	W. H. Seagraves	Reno, Nevada	1125
1126	Well water	County Hospital	Reno, Nevada	1126
1127	Hunter Creek		Reno, Nevada	1127
1128	Well water	Hospital for Mental Diseases	Reno, Nevada	1128
1129	Well water	Commercial Soap Co.	Reno, Nevada	1129

ANALYSES OF WATERS—*Continued.*

Station No.	PARTS PER MILLION.		GRAINS PER GALLON.				Station No.
	Free Ammonia.	Alb. Ammonia.	Chlorine.	Total Solids.	Volatile Solids.	Fixed Solids.	
1001	.03	.012	4.82	30.5	9.5	21	1001
1004	.21	.27	.7	8.5	5.5	3	1004
1005	.03	.093	6	16	3.	13	1005
1006	.01	.18	.9	....	....	....	1006
1007	.01	.07	.9	13	....	....	1007
1008	.05	.116	1	....	....	....	1008
1010	.10	.49	.9	....	....	....	1010
1011	.70	.218	.8	....	....	....	1011
1012	None.	.28	.5	31	....	....	1012
1013	None.	.064	.45	....	....	....	1013
1018	None.	.072	4.60	17	8	9	1018
1019	.034	.130	2	55	13	42	1019
1020	.0583	.144	1	16.5	....	....	1020
1021	.0213	.094	.3	7.17	1.37	5.8	1021
1022	.076	.170	.4	18.70	6.60	12.10	1022
1024	.072	.200	.4	8.20	2.80	5.40	1024
1025	.043	.094	.4	8.20	2.80	5.40	1025
1026	.029	.344	.7	18.8	5.20	13.60	1026
1027	.0266	.034	.3	9.5	5	4.5	1027
1028	.077	.126	1.1	5.8	2.8	3	1028
1029	.04	.126	1	4	3.20	.8	1029
1030	.018	.066	.4	6.10	2.40	3.70	1030
1031	None	.084	.3	4.20	.30	3.90	1031
1032	.04	.118	.5	7	2.5	4.5	1032
1033	.04	.132	.5	9.5	2.5	7	1033
1034	.04	.104	.4	5	2.5	2.5	1034
1035	.053	.132	1	13	6	7	1035
1037	.34	.392	3.4	41	17	24	1037
1038	.104	.228	.9	11.50	7	4.50	1038
1039	.1412	.23	.7	6	3	3	1039
1040	.2426	.214	1.3	17	10	7	1040
1041	.04	.184	.4	11.20	5.5	5.70	1041
1042	.011	.238	2.5	22.50	9	13.50	1042
1049	.085	.27	3.4	45.60	4	41.60	1049
1052	.065	.16	.8	17.70	9.70	8	1052
1054	None	.258	1	14.60	5.90	8.70	1054
1055	None	.02	.7	18.50	8.40	10.10	1055
1058	....	....	....	11.13	2.76	8.37	1058
1060	.17	.17	.2	18	17.4	.8	1060
1062	.0213	.264	.4	19.05	16.00	3.5	1062
1063	.085	.154	.3	1	....	....	1063
1064	.54	.11	.3	....	....	....	1064
1065	.042	.14	.3	....	....	....	1065
1066	085	.084	2.1	....	....	....	1066
1067	.056	.086	.5	....	....	....	1067
1068	.034	.176	.4	....	....	....	1068
1072	.123	.426	.5	5.2	2.2	3	1072
1073	.14	.191	8	17.5	4.2	13.3	1073
1075	.285	.33	.7	16.9	3.2	13.7	1075
1086	.078	.066	2.3	22	....	....	1086
1091	.077	128	.8	17.2	4.2	13	1091

ANALYSES OF WATERS—*Continued.*

Station No.	PARTS PER MILLION.		GRAINS PER GALLON.				Station No.
	Free Ammonia.	Alb. Ammonia.	Chlorine.	Total Solids.	Volatile Solids.	Fixed Solids.	
1095	.0426	.13	.2	7.6	1.8	5.8	1095
1096	.024	.062	.2	9.9	3.6	6.3	1096
1097	.34	.482	.3	5.95	.59	.05	1097
1098	.762	.54	.4	6.4	4	2.4	1098
1099	.408	.75	....	12	7	5	1099
1100	.444	1.25	.5	8.2	5.3	2.9	1100
1101	092	.226	.2	6.5	4.2	2 3	1101
1106	.004	.064	.3	25.3	12 3	13	1106
1107	.068	.024	.14	6.5	5 3	1.2	1107
1109	.093	.22	.5	....	....	....	1109
1110	.18	.196	.4	....	....	4	1110
1111	.09	.16	.4	7	3	.. ..	1111
1113	.15	.25	1	25	10.50	14 5	1118
1115	17	.23	.8	15	5	10	1115
1116	.03	.45	2.8	19	10	9	1116
1117	.05	.03	.55	7	3	4	1117
1118	.056	.035	.55	4.6	3.1	1.5	1118
1119	.048	.126	4.8	....	....	....	1119
1120	.021	.146	3.7	4.9	....	....	1120
1121	....	.046	....	....	....	....	1121
1122	.20	.078	.25	7.7	2.9	4.8	1122
1123	.392	.123	.5	16.8	7.1	9.7	1123
1124	.086	.068	.44	17.8	4.4	13.4	1124
1125	055	.098	.325	14.7	6.7	8	1125
1126	.076	.085	.5	10.1	2.1	8	1126
1127	.104	.074	.25	9.4	1.8	7.6	1127
1128	.026	.048	.2	11.6	5 1	6.5	1128
1129	.02	.063	2.2	13.8	5.4	8.4	1129

EXPLANATION OF TERMS USED IN STATEMENT OF WATER ANALYSES.

The organic matter in waters consists of what is known as Albuminoid and Free Amonia. Of these two, the Albuminoid Ammonia is by far the most important, and is taken as an indication of pollution from either or both animal and vegetable sources, the discrimination being made in accordance with the quantities of Chlorine and Free Ammonia present in a given sample.

An excessive amount of Albuminoid Ammonia, accompanied by any marked quantity of Free Ammonia and Chlorine, owes its origin to animal contamination, but if Free Ammonia is absent or present in unmarked quantities together with little or no Chlorine the source of pollution is regarded as coming from vegetable contamination, which is usually much less noxious than pollution from animal sources.

Chlorine is the measure of the amount of chlorides in the water, and may come from the chlorides naturally in the soil, or when in very marked quantities in inland waters is usually from sewer contamination.

Total solids is, as the name indicates, the amount of solid matter in the water, whether in solution or mechanically mixed.

INTERPRETATION OF THE RESULTS OF WATER ANALYSES.

While no hard and fast standards can at present be laid down, in judging of the fitness of water for domestic purposes, we are guided in general by the following rules, based on Wanklyn's Standards, which are more or less elastic, according to circumstances and an environmental survey of the source of the water.

Unless water contains more than 40 grains per gallon of total solids no exception need be taken to the solids as such.

Five or ten grains of Chlorine per gallon are not an absolute bar to the use of a water, but only a reason for suspicion under certain circumstances.

If a water yield 0.00 parts per million of Albuminoid Ammonia, it may be passed as organically pure, despite much Free Ammonia and Chlorine. If, indeed, a water yield 0.02 or less than 0.05 parts per million of Albuminoid Ammonia it belongs to a class of very pure water. When the Albuminoid Ammonia amounts to 0.05 per million, then the Free Ammonia becomes a factor in the calculation and a water should be regarded with a great deal of suspicion when such is the case.

Free Ammonia being absent or present in very small quantities, a water should not be condemned unless the Albuminoid Ammonia reaches something like 0.10 parts per million. Albuminoid Ammonia above 0.10 parts per million is a very serious thing, and when it reaches 0.15 parts per million the water is regarded as being totally and absolutely unfit for domestic purposes.

According to these rules and related conditions, we classify waters as follows:

Class 1. Waters yielding from 0.00 to 0.05 parts per million of Albuminoid Ammonia. This class comprises the most carefully prepared distilled waters, highly filtered waters; *i.e.* both natural (*i.e.* deep spring waters) and artificial; *i.e.* such water as has passed through a good "silicon-carbon" filter in good working order. Such waters cannot be objected to organically.

Class 2. This embraces the general drinking waters of the country, and are characterized by yielding from 00.5 to 0.10 parts per million of Albuminoid Ammonia. Such waters are usually safe organically.

Class 3. Comprehends the dirty waters and those highly polluted, and yield upwards of 0.10 parts per million Albuminoid Ammonia. Such waters are not fit for domestic use, and when so used may give rise to Diarrhoea, Typhoid Fever, etc.

Taking into consideration the fact that water analysis is an exceedingly difficult part of chemical work, from the fact that the interpretation of results may mean so much, or so little, and that the effects of contaminated water on the human system are, at the present time, such open questions, though the evidence seems convincing, it is manifest that the analyst must be very guarded and if he err at all it should be on the side of safety.

WATER SAMPLES.

Vessels for containing samples—A very good vessel for sending samples of water for analysis is the two-quart Mason fruit jar, but it must be perfectly new. The *best* vessel is the regular "demijohn" used so extensively in this State and California for wines. Even these should be new, and nothing but new corks should be used. If, however, it is impossible to obtain a new cork, *an old one can be used if it is thoroughly boiled before using.*

If the water is to be examined for its fitness for domestic use, *two quarts* should be sent; if a complete mineral analysis is desired *at least one gallon* should be sent.

Taking the sample—Great cleanliness must be exercised in this work; before charging the vessel with water, it must be thoroughly cleansed and then rinsed out with some of the same kind john" used so extensively in this State and California for wines. Even these should be new, and nothing but new corks should be used. If, however, it is impossible to obtain a new cork, *an old one can be used if it is thoroughly boiled before using.*

If the water is to be examined for its fitness for domestic use, *two quarts* should be sent; if a complete mineral analysis is desired, *at least one gallon* should be sent.

Taking the sample.—Great cleanliness must be exercised in this work; before charging the vessel with water, it must be thoroughly cleansed and then rinsed out with some of the same kind of water as that which is to be analyzed. The vessel having been charged with the water, care must be taken that it should not be quite full, but nearly so.

In sampling water from town supplies, it is well to draw the water directly from the mains, and before taking the sample the water should be allowed to run for a few moments, so as to clear the pipes. If the water to be examined is from a river or pond, the entrance of scum, etc., into the vessel must be prevented by immersing the vessel and opening it at a little distance below the surface. In the case of the river, the middle of the stream should be selected, and the outlets of sewers and feeders should be avoided; a note should also be made as to whether there have been recent heavy rains or prolonged drought.

Complete mineral analyses can be made at this laboratory only for the following purposes:

1st. To determine its fitness for irrigation purposes.

2d. To determine its fitness for domestic use.

3d. To determine its fitness for use in boilers for running farm machinery.

In sending samples the above directions must be strenuously carried out or the analysis can not be made at this laboratory.

DAIRY PRODUCTS.

Milk.—It is absolutely necessary to have the sample represent as nearly as possible the whole lot of milk from which it is taken, and it is a much more difficult matter than many suppose.

The most reliable method of sampling is by the use of a sampling tube which takes out a core of milk from the top to the bottom. This sampling tube can be made by any ordinary tinsmith by taking a piece of brass tubing an inch in diameter, running a wire through the length of it, terminating at the upper part in a bend for handle, the other end of the wire being soldered into a firm sheet of iron which is covered on its upper surface by a piece of rubber packing. This iron valve should be a trifle larger than the size of the tubing. The wire is held in the center of the tube by a small wire loop at the top and bottom, near the ends of the tube. By pushing down the handle the valve is carried away from the bottom of the tube, leaving a place for the milk to enter. While in this position the tube is pushed down vertically into the milk in the weighing can until it reaches the bottom. The wire is then pulled up, closing the bottom of the tube, taking with it a core of milk from the top to the bottom of the can. The bottom of the tube is put into the can or jar in which the sample is to be kept, and by loosening the valve the milk is allowed to flow out. Three such samples will furnish enough milk for a sample for analysis, and will give a sample that is a correct average of all the milk. But even when using this it is advisable to stir the milk well with a dipper before taking the sample. Of course if the amount of milk is small, one hundred or two hundred pounds, and it is stirred very thoroughly with a large dipper, it can be mixed so thoroughly that a correct sample may be taken out with a dipper.

In sampling small quantities of milk, as in the case of sampling for testing individual cows or a whole herd, it is well to have a small dipper holding about one-quarter or one-half a pint and thoroughly stir the milk in the bucket as soon as the cow is milked and dip the sample quickly, plunging the dipper clear to the bottom of the pail and dipping upward.

In testing an individual cow or herd, it is best to take samples for a week, night and morning, thus obtaining what is known as a "composite" sample, which gives a good average of what the animal or herd is doing. These samples are taken as above described, having as many jars as you have cows to test, or, in case you are testing the whole herd collectively, one large, two-quart jar. Take a sample, say commencing Sunday morning; set it in a cool place, and at night take another sample in the same way and add to that taken in the morning, and so on until the fourteen milkings constituting the week's samples have been taken. Regulate the size of the samples so that at the close of the sampling period the jar will be so full that the milk will not churn in trans-

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SOME COMMON INJURIOUS INSECTS OF WESTERN NEVADA.

F. H. HILLMAN.

INTRODUCTORY.

The following list of injurious insects is not to be considered complete, either in the number of species mentioned or in the mode of their treatment. It includes such injurious insects as are known to occur commonly in the western part of the State, and which have attracted more or less popular attention for a number of years.

By the consideration of the injuries produced by insects as plant diseases, and the especial designation of the diagnostic evidences of their injury, it is hoped that the identification of the specific nature of the disease may not be found difficult. A key based upon the principal characteristic evidences of the various kinds of injury is given as an aid in making the identifications. In using this key, the reader will be guided by the several heads and sub-heads in the order of their importance.

As a number of the insects included here have been discussed in former bulletins from this department, which are still to be had upon application, these are simply referred to, their subject matter not being repeated. F. H. H.

January 19, 1898.

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Key for the Determination of Injurious Insects of this List.

(Based chiefly on the character of their injury.)

I. Insects affecting the larger fruits.

a. Affecting the appearance of the whole tree.

(1) Apple trees assuming a sickly appearance; the roots knotted or covered by brownish lice.
WOOLLY APHIS, No. 21. (2).

b. Affecting the trunk and branches.

(1) Producing an ashy gray, scurfy covering on the bark, yielding a yellowish oily substance on crushing with the nail.
(Infesting fruit trees and garden shrubs generally). SAN JOSE SCALE, No. 31.

(2) Destroying the bark and exposing furrowed, cracked, and perforated wood with more or less sawdust-like excrement.
(Infesting various fruit and shade trees.) FLAT-HEADED BORER, No. 1.

(3) Wounds of any kind and "sprouts" bearing patches of white woolly material covering brown soft-bodied insects.
(Of fruit trees, confined to the apple.) WOOLLY APHIS, No. 21.

(4) White cocoons ½ to ¾ inch long found in autumn and winter under scales of bark.
(Occurring chiefly on apple and pear.) CODLING MOTH, No. 10.

(5) Minute brick-red mites often found in great numbers crawling over the branches.
(Infesting fruit trees and shrubs, also some shade trees.) RED SPIDER, No. 39.

(6) The branches of young trees exhibiting longitudinal slits in the bark, a row of eggs under the edges of the slits; bark becoming rough and knotted.
(Both fruit and ornamental trees and shrubs affected.) BUFFALO TREE HOPPER, No. 38.

c. Affecting the twigs.

(1) Twigs exhibiting a scurfy appearance or circular scales singly or in clusters. (See b. (1) above.)
SAN JOSE SCALE, No. 31.

(2) Apple twigs presenting white woolly patches, particularly at the leaf axils; or, rough and irregularly scarred, insects not evident. (See b. (3) above.) WOOLLY APHIS, No. 21.

(3) The bark exhibiting small longitudinal slits, the edges of which are dead and discolored, each covering a row of eggs. (See b. (6) above.) BUFFALO TREE HOPPER, No. 38.

(4) Numerous small soft-bodied insects clustered on the young growth.
(Apple Leaf Louse, No. 20, PLANT LICE, No. 19.
Woolly Aphis, No. 21.)

(5) Upper branches and twigs more or less covered by small black objects—having the appearance at a short distance of being thickly "fly-specked."
(A winter condition of Eggs of APPLE LEAF LOUSE, No. 20.
young apple trees.)

(6) The smaller twigs covered by a very fine web containing minute red mites. (See b. (5) above.)
(Various trees and shrubs affected.) RED SPIDER, No. 39.

d. Affecting the leaves.

(1) Leaves exhibiting minute circular or oblong scales along the veins, at least on the upper surface; also, often yellow or spotted. (See above, b. (1), c. (1)). SAN JOSE SCALE, No. 31.

(2) Numerous soft-bodied insects chiefly on the lower surface of the leaves.
(Apple Leaf Louse, No. 20, PLANT LICE, No. 19.
Plum Leaf Louse, No. 23.)

(3) Leaves turned brown, the foliage assuming a scorched appearance caused by small slimy worms.
(Affecting pear, cherry, PEAR AND CHERRY SLUG, No. 2.
and plum.)

(4) Leaves with a fine web covering the lower surface and inclosing numerous minute red mites; these leaves eventually becoming lighter colored than the healthy ones. (See above, b. (5) and c. (6)). RED SPIDER, No. 39.

e. Affecting the fruit.

(1) Apples and pears bored internally about the core; brown granular excrement occupying the cavity and often protruding from the "blossom" or the side of the fruit. CODLING MOTH, No. 10.

(2) Fruit exhibiting minute, mostly circular, scales upon the surface which, if light colored, is usually reddish purple tinged about the scales. (See above, b. (1), c. (1), d. (1)).
SAN JOSE SCALE, No. 31.

(3) Young apples and pears gnawed by a light green fleshy worm.
ASH GRAY PINION, No. 11.

II. Insects affecting ornamental and shade trees.

a. Affecting the trunk and branches.

(1) Discolored spots on the bark wet from exuding sap, the bark often cracked or broken away disclosing granular excrement and perforated wood. LOCUST TREE CARPENTER MOTH, No. 9.

(2) Bark breaking away exposing furrowed, cracked, and perforated wood, and sawdust-like excrement. (See b. (2) above.)
FLAT-HEADED BORER, No. 1.

(3) Reddish brown flattened or hemispherical protuberances ¼ inch or less in diameter on the branches.
(Infesting various trees and shrubs.) LECANIUM BARK LICE, No. 34.

(4) Elm trees exhibiting whitish patches of old insects on the lower surface of the branches; clusters of minute grayish insects in protected spots on the bark in winter and spring.
IMPORTED ELM BARK LOUSE, No. 36.

(5) Small mussel-shaped dark brown scales on the bark of branches and twigs.
(A serious enemy of apple in the east and middle west.) OYSTER-SHELL BARK LOUSE, No. 33.

(6) Box-elder and cottonwood limbs dying, the bark dark spotted or having a scurfy covering of circular scale insects.
(Other trees often infested.) ENGLISH WALNUT SCALE, No. 32.

(7) Box-elder twigs exhibiting white cottony masses on the sides of the branches and on the axils of the twigs.
(Infesting other trees.) COTTONY MAPLE SCALE, No. 35.

b. Infesting the leaves.

(1) Branches of elms and willows stripped of their leaves by black spiny caterpillars. MOURNING-CLOAK BUTTERFLY, No. 4.

(2) Leaves of poplar and cottonwood eaten by large fleshy, light green worms. POPLAR HAWK MOTH, No. 8.

(3) Minute grayish insects clustered along the veins of elm leaves. (See II, a. (4) above).
IMPORTED ELM BARK LOUSE, No. 36.

(4) Leaf stems of cottonwood bearing a hollow swelling containing insects. POPLAR LEAF-GALL LOUSE, No. 28.

(5) Soft-bodied insects clustered on the leaves, often on the twigs.
Some form of PLANT LICE, No. 19,
On cottonwood, see COTTONWOOD LEAF LOUSE, No. 27.

(6) American elm exhibiting clusters of crumpled leaves enclosing lice.
ELM LEAF LOUSE, No. 26.

III. Insects affecting ornamental shrubs, vines, etc.

(1) Flower buds of roses gnawed into from the side; the petals perforated or falling away on opening. (See I. e. (3) above).
ASH GRAY PINION, No. 11.

(2) Young growth of roses often covered by brownish soft-bodied insects.
ROSE PLANT LOUSE, No. 24.

(3) Leaves of roses becoming light spotted; small white insects on the lower surface, jumping away when disturbed.
ROSE LEAF HOPPER, No. 37.

(4) Rose stalks exhibiting roughened rows of perforations in the bark.
SNOWY TREE CRICKET, No 18.

(5) Leaves of the hop eaten and skeletonized by spiny worms.
HOP-VINE BUTTERFLY, No. 6.

(6) Leaves of hollyhock eaten by black spiny worms feeding beneath a web. HOLLYHOCK BUTTERFLY, No. 5.

IV Insects affecting garden shrubs.

(1) Raspberry and blackberry stalks exhibiting roughened rows of perforations in the bark. (See III, (4) above.)
SNOWY TREE CRICKET, No. 18.

(2) Currant and gooseberry stalks bored along the pith, brown excrement present, a whitish worm often present.
CURRANT STEM BORERS, No. 12.

(3) Currant and gooseberry stalks exhibiting an ashy, scurfy, surface; dying; dead leaves retained. (See b. (1), c. (1) and d. (1) of I. above). SAN JOSE SCALE, No. 31.

(4) Currant bushes exhibiting crumpled clusters of leaves at the tips of the stems; insects within. CURRANT LEAF LOUSE, NO. 25.

(5) Currant stalks bearing reddish brown protuberances ⅛ of an inch or less in diameter. (See II a. (3) above).
LECANIUM BARK LICE, NO. 34.

V. Insects affecting garden vegetables.

a. Affecting the cabbage.

(1) Leaves perforated, often skeletonized.

a. By green velvety worms.
IMPORTED CABBAGE BUTTERFLY, NO. 3.

b. By smooth light green, hump-backed worms.
CABBAGE PLUSIA, NO. 13.

c. By colonies of dark colored worms, or by larger worms brightly colored with black, white and yellow.
(Other plants infested.) ZEBRA CATERPILLAR, NO. 15.

d. By very small light-green worms; a thin membrane covering the smaller gnawed spots.
(Turnips and radishes also infested.) DIAMOND-BACK MOTH, NO. 17.

(2) The leaves exhibiting colonies of green, mealy-skinned lice, chiefly on the lower surface. CABBAGE LOUSE, NO. 22.

(3) Young plants gnawed off at the surface of the ground.
CUTWORMS, NO 10.

b. Affecting other vegetables.

(1) Ears of garden corn burrowed by striped worms.
CORN EAR WORM, NO. 14.

(2) Tomato leaves eaten by a large fleshy worm.
TOMATO WORM, NO. 7.

(3) Tomatoes bored into by striped green or brown worms.
CORN EAR WORM, NO. 14.

LIST OF INJURIOUS INSECTS.

No. 1.

FLAT-HEADED APPLE TREE BORER—*(Chrysobothris femorata)*—*Diagnosis:* Apple and other fruit trees are frequently destroyed by this insect whose presence is shown, in an advanced stage of attack, by the dead and cracked bark of the trunk and limbs. Usually more or less of the bark has fallen away exposing the dead wood and considerable sawdust-like excrement, the wood furrowed and punctured with oval holes. Trees having this appearance have probably been affected for several years. Young trees are apt to assume a sickly appearance. The bark covering spots affected by the insect becomes sunken and discolored, dies and cracks. Weak trees are ordinarily affected worst.

The insect in question is a beetle in the mature stage. It is rarely seen except on warm bright days in early summer, when it is sometimes found basking in the sun on the trunk and limbs of the trees.

The larva which does the mischief is creamy white, ½ to ¾ of an inch long, the portion of the body just back of the head broad and flat, (whence the common name), the remainder of the body slender, rather bead-like, and almost always bent around to one side bringing the two extremities near together. The larva, which is ordinarily easily found, is practically sufficient to identify the insect.

The eggs are laid in early June in rough places on the bark. On hatching, the young worms eat through the bark, then feed for the greater part of the season upon the young wood just beneath. Old trees thus affected show from a third to a half of the diameter of the infested limbs with the young wood eaten away, often for a distance of several feet along the limb or trunk, as the case may be. The bark is in this way killed and eventually falls away. The exposed part of the wood is furrowed, the furrows frequently filled with the sawdust-like castings of the larva. It dies and usually checks. Oblong holes in the wood, some open and others filled with dust, show that the larvæ penetrated the wood after destroying the young sap-wood. Within the burrows in the wood, the worms change to white pupæ which in spring transform again becoming mature beetles. The beetles are about half an inch long, somewhat flattened, dark green on the back with a bronzy lustre, the bronzy or coppery lustre particularly evident beneath. The sexes vary somewhat in size.

Strong and vigorous trees are ordinarily not infested by this insect owing, probably, to their large quantity of sap. On the other hand, weak trees of any age, and young trees recently transplanted are very commonly affected in all parts of the country. Furthermore, it will be noticed that the south and southwest sides of the trees are most commonly attacked. Owing to the small diameter of young trees, these are frequently completely girdled before the larvæ enter the wood.

The complete control of this insect is attended by considerably more difficulty than is experienced in the cases of many others. It is, however, none the less important.

In the case of young trees, weakened by transplanting, careful examination should be made to determine the presence of the larvæ. Digging them out with a knife blade is the first and most important step. In autumn the appearance of the bark, as stated above, may reveal the presence of young borers which will demand like treatment. Soap has proved to be a good repellent of the beetles; hence, washing the trunk and lower limbs of the trees with strong soap water, beginning about the middle of May, and repeating as often as necessary during summer, will be found valuable in preventing the laying of eggs. The addition to the wash of sufficient crude carbolic acid to give it a distinct odor, will doubtless make the wash more effectual. Fish-oil and whale-oil soaps are valuable kinds to use in this work. Other materials to be used in spraying are advised, but the soap wash is given here owing to its availability. The common practice of whitewashing the trees is not wholly without purpose against this insect. The work should be done thoroughly and during the same period as given for the application of the soap. The benefit arising from the use of whitewash lies in the inability of the young larvæ to penetrate the coating of whitewash in trying to enter the bark. Keeping the tree free from old scales of bark is of advantage.

While this insect is designated as an apple-tree borer, it is nearly as frequently found infesting other fruit trees, pear, peach, plum, etc., also the stalks of the currant. Perhaps less frequently, but not uncommonly, it injures various shade trees.

No. 2.

Pear and Cherry Slug—(*Selandria cerasi*)—*Diagnosis:* Each year in June and July, pear and cherry trees become infested by small, shining, slimy, olive green worms which feed on the upper surface of the leaves causing them to turn brown in spots, or eventually, wholly so. If badly infested, the tree assumes a scorched appearance and sometimes the leaves fall away entirely, a new foliage taking their place.

This very evident injury to these trees is caused by an insect which, in the mature stage, is a small, black, four-winged fly less than a quarter of an inch in length. This stage of the insect is rarely seen, though the injury producing larvæ are well known to orchardists in western Nevada.

Bulletin No. 10 of this Station contains an account of this insect which is not repeated here.

The insect is not a difficult one to control if the essential features of its life-history and habits are borne in mind in the application of remedies.

There are two broods of insects developed each summer. In early June mature flies emerge from their cocoons in the ground where they have remained over the preceding winter. Eggs are deposited in the substance of the leaves just beneath the upper surface. In a couple of weeks the young larvæ appear, breaking through the upper skin of the leaf on hatching. They at once begin to gnaw away the upper surface, excepting the veins. For nearly three weeks this proceeds, during which time the larvæ attain their growth, and near the close of which they cast the slimy skin. They soon after leave the foliage and go into the ground. There they form brown oblong cocoons a few inches beneath the surface. A couple of weeks later they emerge as perfect insects and proceed to deposit eggs for a second brood. The larvæ of the second brood remain on the leaves during the greater part of August when they, too, go into the ground to remain until the following June.

Thus, from the habits of this insect, it is seen that the spraying of remedies should be done at various times in June and again in August, when the larvæ are upon the foliage. On each occasion, this should be begun early enough to prevent the injury to the tree. Again, since the insects spend a part of their existence in the ground but a short distance beneath the surface, it is evident that active cultivation of the soil beneath and about the trees soon after the first brood of larvæ has disappeared from the leaves, and again in autumn, would destroy many insects, which, in the case of an isolated orchard, would be of material benefit.

The following is taken from the bulletin cited above:

"The experiments with tobacco decoction, white hellebore and buhach, performed at the Experiment Station, prove the value of these as remedies for the pear slug. A double handful of refuse tobacco was boiled and the decoction diluted to form eight or ten gallons. A table-spoonful of white hellebore to five gallons of water, and the same amount of buhach in the same amount of water, were separately sprayed upon different trees, resulting in each case in the death of nearly all the slugs. A second application took them all. These being vegetable compounds, no injury to the foliage is at all likely to result, which is not always true in the use of inorganic compounds."

No. 3.

IMPORTED CABBAGE BUTTERFLY—(*Pieris rapæ*)—*Diagnosis:* During summer, the leaves of cabbages become perforated and large holes often extending to the veins are produced by green velvety-skinned worms. Various sizes of the worms are to be found, the largest somewhat over an inch in length. They may occur on all the leaves, particularly on the intermediate ones, and those immediately about the head. These are often completely skeletonized, the denuded veins standing upright in conspicuous evidence of the presence of this insect.

Gray, speckled chrysalids about three-fourths of an inch long, suspended from the pointed extremity and by a silken loop, are often found attached to the leaves or other objects near by.

The presence of white butterflies, seemingly confined to the cabbage area, is almost sure indication of the presence of these worms in destructive number.

This is an imported insect which has became naturalized in nearly all parts of the United States. It was first seen about Reno in 1895, since which time it has become very common. For the past two years it has been very abundant and has proved very injurious to cabbages. The writer has found it on mignonette completely stripping the plants of leaves. It seems to be two brooded in this locality, the first butterflies to be seen certainly not later than early June.

The insect's eggs are laid upon the leaves of the cabbage. The young larvæ feed until maturity as indicated in the diagnosis. Some of them form the chrysalis on the under surface of the leaves upon which they have fed, while others leave the plants, seeking some over-hanging shelter near at hand. The period of appearance of the second brood of butterflies is irregular, which results in both the butterflies and the worms being found until the close of the growing season.

These worms cannot be mistaken for any others now known to infest garden plants in Nevada. Their light to dark green color, velvety surface, a narrow yellowish line along the back, another line and a row of yellowish dots on each side, should serve to make their identification practically certain. The wings of the butterflies are white above, somewhat yellowish beneath, the front wings being black at the tip, a black spot on the front edge of each hind wing and one (in the male) or two (in the female) additional black spots on each front wing. The wings' expanse varies from 1½ to 2 inches.

The above description will serve in distinguishing this insect from the common native white butterfly, *(Pieris occidentalis)*, whose larvæ sometimes feed upon cabbage, though more commonly upon various weeds belonging to the same family as the cabbage, notably, the common hedge mustard, *(Sisymbrium canescens.)* The larva of the latter insect is yellowish with black spots; the butterfly having numerous black spots and lines on a white background.

Spraying the plants with buhach or white hellebore destroys these insects without danger of injury either to the plants, or their consumers. The writer has found the use of these powders, combined with kerosene emulsion at the strength of 1-16 oz. of powder to each gallon of the emulsion as used, to be destructive to these larvæ, the emulsion killing the equally destructive cabbage lice, though not fatal to the butterfly larvæ when used without the buhach or white hellebore.

Destroying the useless outer leaves of the plants will also destroy many of the chrysalids of this insect.

No. 4.

MOURNING-CLOAK BUTTERFLY—*(Euvanessa antiopa)*—*Diagnosis:* Branches of the elms and willows are often defoliated by colonies of purplish black caterpillars. They remain in a colony migrating in a body from a defoliated branch to a new one.

These caterpillers are the larvae of a very common butterfly which may be seen at almost any time from earliest spring until very late autumn or even on warm days in winter, as, unlike most of the butterflies, this one passes the winter in the butterfly stage. The wings are deep purplish brown bordered by a band of yellow sprinkled with brown, a band of black just within this containing a row of blue spots, and a pair of yellowish spots occurring on the front edge of each front wing. The wings expand about two and a half inches The full grown caterpillars are two inches or more long, purplish black, sprinkled with white, a row of red spots along the back, the body covered with sharp spines.

There are, probably, two distinct broods of this insect in Nevada, the first brood of larvæ appearing about June, the second in August or September.

The butterflies are very common in spring and again in early autumn. Those of early spring often have torn wings showing that they have passed the winter in the butterfly stage.

It is said that these caterpillars feed upon a variety of trees and shrubs, but here they have been noted only on the elm and willows, particularly the latter, which line rivers, ditches and mountain streams everywhere in this region.

Owing to the fact that the caterpillars feed in colonies, cutting away and destroying infested branches is the most practicable remedy to employ.

No. 5.

HOLLYHOCK BUTTERFLY—*(Vanessa caryæ)*—*Diagnosis:* Each year about the time the stalks of the hollyhock are full grown, the leaves begin to present gnawed patches on the upper surface, which is more or less covered by a web by which the edges of the leaves are drawn together upward; or, in larger leaves, the edges are drawn over against the upper surface. One or more spiny caterpillars are, ordinarily, under each web.

The hollyhock is annually injured by the larvæ of this butterfly, often to a serious extent, as has been observed at the University, where certain plants growing in a warm, bright and protected spot have been practically defoliated on each of several years past. The effect on the flowers has been very noticeable, as they have scarcely attained half the usual size, and have presented a sickly appearance otherwise. When the full effect of the injury to the plants appeared, the leaves presented the appearance of having been scorched, as by fire.

The parent of this insect is a very common, reddish, spotted butterfly to be seen from spring until late autumn. It seems to have the habit of alighting on the ground, soon flitting away a few feet or yards and alighting again, thus being one of the few butterflies seemingly always in one's path on warm, bright days. This habit is accounted for by the fact that the common mallow or "cheeses" is abundant everywhere about the streets and dwellings. This plant is closely related to the hollyhock and its leaves are commonly fed upon by the larvæ of this butterfly, which is actively depositing eggs upon the leaves, while apparently aimlessly flitting about on the ground.

In like manner, the eggs are laid on the hollyhock leaves at different times in spring and early summer, consequently larvæ of different sizes are to be found at the same time feeding upon this plant.

There appears to be two broods of this insect annually, there being a period in summer of comparative cessation of the attack of the worms. Spraying the plants with Paris green before the eggs have hatched, should prevent the injuries from these caterpillars.

Another butterfly, *Vanessa cardui*, closely related to the one just described, which feeds on the hollyhock in other parts of the country, is common in this region, but thus far has not been found feeding on the hollyhock here.

No. 6.

HOP-VINE BUTTERFLY—*(Grapta satyrus)*—*Diagnosis:* The leaves of the hop-vine are very commonly eaten away and skeletonized, when only the principal veins remain, by a spine-covered white-backed caterpillar, which spends the day in hiding on the lower surface of the leaves.

There are at least two broods of these caterpillars, and they may be found from midsummer or earlier, until late autumn. They are an inch or more long at maturity, when they form a grayish chrysalis having some silvery spots on one side. The chrysalids are suspended from some overhanging object in the immediate vicinity of the plants upon which they have fed. From the chrysalis, there develops a beautiful reddish, brown spotted butterfly, the wings of which expand nearly two inches. Another very similar species, *Grapta sephyrus*, which commonly feeds on wild plants, is occasionly found on the hop.

The use of Paris green spray, where hand picking of the larvæ is not feasible, would probably hold this insect in check.

No. 7.

TOMATO WORM—*(Phlegethontius celeus)*—*Diagnosis:* The leaves of the tomato, potato and also tobacco are injured by a large fleshy, usually green, worm. The leaves are eaten away, only the larger veins remaining.

This is a very common insect familiar in the larval stage, at least, to most people. The larva is three or four inches long at maturity, green or sometimes brown in color, having several diagonal lighter stripes on each side and a horn-like projection near the hinder extremity. In the latter part of summer the worms burrow into the ground and change to reddish brown chrysalids about two inches long. The tongue of the future moth is folded back against the body of the chrysalis "jug-handle" fashion. These chrysalids are often brought to light by the plow or cultivator in the early preparation of ground previously used in growing the plants upon which this insect feeds. There eventually developes from the chrysalis a large moth having a wing expanse of four or five inches. The wings are ashy gray, beautifully variegated and cross marked with bands of black. The body is black, white and yellow spotted. The moths fly at night sipping the nectar of flowers. They are attracted and many of them destroyed by electric lights.

Hand-picking the larvæ from the plants is the most practical means of disposing of them

No. 8.

POPLAR HAWK MOTH—*(Marumba modesta)*— *Diagnosis:* Large fleshy worms are frequently found eating the leaves of the poplar and cottonwood. They may be found crawling on the trunk of the tree or the ground in the vicinity of these trees. One's attention is frequently directed to them by their conspicuous excrement lying on the ground beneath the branches upon which they are feeding.

When full grown, these larvæ resemble, somewhat, the large worms which feed upon the tomato. They are then about the size of one's finger and measure about four inches in length. They are light green in color, simulating the color of the leaves upon which they feed. Upon each side are several light diagonal stripes, and near the hinder extremity is a horn-like projection. The head, a saddle-like area just back of the head and the hinder extremity of the body, have a rough granular surface. When mature, in the latter part of summer or early autumn, they go into the ground and transform into robust, reddish brown chrysalids, in which form they remain until spring, when the mature insect emerges as one of our largest moths, having a wing expanse of about five inches. The color of the moth is most modest, the front wings, usually, a faded light brown with more or less distinct wavy cross markings. The hind wings are characteristically reddish purple in the center with dark spots near the hinder angle. The moths are very commonly attracted by electric lights, their burned bodies often being found beneath the lamps in the morning.

This insect has not been found sufficiently common about Reno to be materially injurious to the poplars and cottonwoods. It was, however, reported upon one occasion, from Hawthorne, as having seriously defoliated the cottonwood trees there.

Should it become a serious insect in any locality, the thorough cultivation of the ground about the trees in late autumn would very materially reduce the number of insects which would otherwise appear the following year. The use of the arsenical poisons, Paris green and London purple, would probably prove effective in protecting individual trees.

No. 9.

LOCUST TREE CARPENTER MOTH—*(Prionoxystus robiniæ)* —*Diagnosis:* Various shade trees, as the locust, elm and poplar, often exhibit evidence of the presence of a large boring insect working in the trunk or larger limbs. This may appear as discolored moist spots on the bark; or, in addition, the bark may be broken away, exposing a mass of wet or dry granular excrement and fine chips, and frequently large holes leading to the interior of the tree.

Such is the common external evidence of the presence of the locust tree carpenter moth. On cutting open the trunk or limbs at the point of infestation, burrows the size of the finger, or smaller, are found to penetrate the wood, often to the centre. One or more fleshy larvæ will also be found. These have a brown head, the body pinkish or yellowish white The size may be variable, some of them being three inches or more long. The insect passes two or three years in this stage while attaining its growth, when it forms a brownish chrysalis near the exit of one of its burrows. At the close of this period the chrysalis wriggles its way to the exit and transforms into the mature moth. The two sexes differ considerably in size and general appearance. The female is gray, in general, resulting from a network of lines and spots of dark brown against a whitish background. The wings expand nearly or quite three inches, but lie folded over the back of the insect when at rest. The male is scarcely more than half as large, the hind wings tawny, bordered with dark brown.

The moths fly in summer, many of them being attracted to electric and other lights. The eggs are laid in the crevices of the bark.

This is a difficult insect to control. By keeping the trunk and branches thoroughly washed with strong soap, with the possible addition of some crude carbolic acid, it is probable that many of the moths would be repelled from the trees during the egg-laying season. Choice shade trees should be frequently examined for evidence of the presence of the young larvæ.

No. 10.

CODLING MOTH—*(Carpocapsa pomonella)*—*Diagnosis:* – The larval stage of this insect is that which gives us the "wormy" apples so well known by every one. Other orchard fruits are sometimes injured by this insect, but it is most widely known as a pest of apples. Its presence in the orchard is recognized by the reddish brown excrement protruding from the blossom end, or from holes in the side of the fruit. In the case of early varieties, many wormy apples will be found on the ground, having fallen prematurely. The removal of old scales of bark after mid-summer will disclose white cocoons half an inch long lying beneath them. These cocoons may also be found in spring in the crevices or corners of boxes or bins where apples have been stored during winter.

On cutting open an infested apple near the period of maturity of the larva, the injury will be seen to have apparently centered about the core and will often show the origination to have been at the blossom. The larva, a half inch or more long, when full grown, is usually pinkish with a brown head. If shaken from the apple, it will often drop by a slender silken thread, a means for leaving the fruit often practiced in the orchard. The cavity caused by the larva is discolored and partly filled with brown excrement; and, if examined after the larva has left, will be found to have a communicating tunnel leading to the surface, usually at one side.

This insect has been treated somewhat at length in Bulletin No. 8 of this Station, and again more briefly in Press Bulletin No. 4, issued in April, 1893. Only the essential features of its life-history having bearing upon the remedies employed thus need to be given here.

The parent insect, a grayish-brown night-flying moth having a wing expanse of about three-fourths of an inch, is rarely seen by those not particularly interested in insects. The first moths of the season come forth in May or early June, from cocoons in which they have passed the preceding winter in an undeveloped state. During the week or two following their appearance, eggs are deposited for the second brood. The belief respecting the egg-laying habits of this insect which has prevailed for many years, seems to be overthrown by observations made by Prof. F. W. Card, in Nebraska in 1897, and reported in Bulletin No. 51 of the Nebraska Experiment Station. These observations go to show that the eggs, with comparatively few exceptions, are laid on the upper surface of the leaves, particularly those near the fruit clusters. Further, that the larvæ frequently feed to some extent upon the leaf tissue before entering the fruit; also, that in endeavoring to secrete themselves while entering the apples, they may enter either at the calyx cup or blossom end, or at some other point on the surface, as where two apples touch. In the majority of cases observed, entrance was made at the calyx.

Upon hatching, the young worm gnaws its way to the interior of the fruit. In from four to six weeks it completes its growth and leaves the fruit seeking some protecting crevice, as beneath scales of bark, in which to form its cocoon. In a couple of weeks a second brood of moths appears from these cocoons. The egg-laying process is now repeated, but differs from the first, in that the eggs are mostly placed on the sides of the fruit, notably where the apples touch each other, or an adjacent twig.

Throughout the intermediate belt across the continent, two broods occur each year. In the north, but one is usual, while in the south three are reported. In Nevada, two broods annually is doubtless the rule.

In any case, the larvæ of the last brood hibernate either within stored fruit or in cocoons, the moths emerging the following season.

Based upon the preceding outline of the life-habits of the codling moth, we have various remedies and means for lessening the number of the insects.

The commonest and most effectual means formerly employed, and one still servicable in the latter part of summer and autumn, is that of banding the trees by placing loosely a band of burlaps about the trunk. Beneath this many cocoons are formed. By removing the band in autumn or winter, and dipping it in boiling water, many future moths are destroyed. Bands of paper may be used instead of burlaps. These are cheaper and may be burned when removed, new ones being placed in their stead. By well stocking the orchard with hogs in early summer, and again in autumn, infested windfalls are profitably disposed of.

Because of the fact that the moths fly at night, trapping them by lights has been attempted—a useless practice, since while many other moths are attracted to the light, the codling moth is not.

The course which has been found most satisfactory, both in reducing the number of insects, and in protecting the fruit the same season as followed, has been the use of Paris green or London purple in water mixture. These are arsenical poisons, and the theory of their use is that the codling moth larva in gnawing through the surface of the fruit, which has been previously poisoned by spraying, receives a fatal quantity of the poison, and is thus prevented from entering the fruit. The idea of danger to man and the higher animals resulting from this course has been proved a falacy. (See Bulletin No. 8 of this Station.) While both these poisons have been employed successfully, Paris green is given the preference since its strength is more constant and its purity is more easily determined. They are employed in simple mechanical mixture with water, at the strength of one pound of Paris green to 200 gallons of water, or a pound of London purple to 150 gallons, at the usual strength of London purple. Continued agitation of the mixture while being applied is required in order to maintain a uniform strength. The addition of a pound of unslacked lime to the above amount is of benefit in preventing the burning of the foliage.

The first treatment is the most important, and the proper time for its performance is most easily determined. It should be made within a few days, at the most, after the blossoms have fallen. The writer believes that this application should be made as soon as the blossoms are wholly gone from the trees. In some localities, the appearance of the moths may not occur for a week or more after the fall of the blossoms, in which event it might not be necessary to spray so early; but, until this interim is proved to be constant for all parts of the country, which the writer does not think will result, it will probably be found better that the first application be made as suggested, as soon as the tree is wholly out of blossom. It is not advisable to spray while the trees are in blossom for two reasons: namely, the very possible danger of killing honey bees; and, of destroying the essential organs of the flowers and thus preventing the formation of the fruit. Like the first, the time for the second application should be based upon the condition of the young fruit at the time it is made. Prof. Card, in Bulletin No. 51 of the Nebraska Station, has pointed out the importance of spraying while the calyx cup, or "basin," of the young fruit is still open. Thus, if a second spraying is to closely follow the first, it would be most advantageously done within two weeks after the fall of the blossoms, say a week and a half following the first application. The very important question of further applications, probably, cannot be answered by the designation of definite dates for spraying owing to the great irregularity of the breeding habits of the insect after mid-summer. However, three or four applications following the two above mentioned, made at the somewhat arbitrarily taken period of fifteen days apart, may prove of much value. Care will have to be taken, however, to prevent the injury to both foliage and fruit that is apt to result from such frequent treatment.

The following account of spraying done by this department was presented as Press Bulletin No. 10, issued in October, 1893:

"In June of the present year [1893] the Entomological department of the Experiment Station undertook experiments to determine the efficiency of spraying with Paris green in preventing the destructiveness of the codling moth, the parent of the worm so injurious to the apple crop of Nevada. Efforts in this direction have been made in previous years, but they have been confined to one, or at most, a few trees at a place. In some of these cases the result was very satisfactory, while in others it was but partially so. This variation in results has, without doubt, been chargeable to a lack of care in the application of the poison. The results in those cases that were satisfactory were quite apt not to be considered as indicative of results in field practice, owing to the small number of trees treated in each case. Thus it was to determine the cause of former failures, and to make the conditions of the experiment conform as nearly as possible to those of actual field practice, that the following work was performed:

"A block of forty-eight trees in the orchard of Mr. A. B. Williams, on Sixth street, Reno, was selected for treatment, the remaining portion of the orchard being left untreated to serve as a check upon the work. To improve the conditions of the experiment in this respect, the two adjacent rows of the two portions of the orchard are of the same variety (the Ben Davis), and each was well laden with fruit. The poison used was Paris green in water mixture at the strength of one pound to 225 gallons of water. During the process of application, much care was taken that as complete mixture as possible and thus a uniform strength should be maintained. While care in this respect permits the fruit to receive more nearly uniform treatment, it is most important in preventing the injury to foliage due to too great strength of poison, which tends to settle to the bottom of the vessel from which it is drawn.

"The first application was made June 1st and 2d. The row of Ben Davis trees was given a second treatment on June 24th. The remaining trees thus received but a single application, that of June 1st and 2d. At the time of the first treatment the blossoms were falling. On the second application the average size of the fruit was that of a walnut.

"An examination of the orchard in the second week in September, when a fairly careful observation of the trees was made in passing from one to another, resulted in there being found less than a dozen examples of wormy fruit on the trees which had received the preventive treatment. The row twice sprayed, apparently, had been much benefited by the second application.

"An examination of the portion of the orchard not sprayed showed a large percentage of the fruit to be wormy. This was particularly noticeable on the row of Ben Davis trees *adjoining that of the same variety which was sprayed.* The fallen fruit naturally showed a greater percentage injured, but the relative proportion of such in the two parts of the orchard seemed not materially different from that in the fruit still on the trees.

"It is to be noted that the examination was not a close one. Greater care in this respect would have revealed more injured fruit from the trees experimented upon. However, the effect of the work was noted very much as it would be ordinarily in picking the fruit.

"The result of similar spraying by Mr. Wm. E. Gould in his orchard east of town is very satisfactory. Here, too, there appears a noticeable difference in favor of trees sprayed twice, over those receiving a single application.

"It is believed that one of the most important factors in the work in each of these cases was the use of the "extension" pole, by which the spray nozzle was brought in close proximity to the young fruit, thus permitting it to become thoroughly wet

"While exact information on the above results is not available, sufficient can be determined to make them very satisfactory, and the scale upon which the work was undertaken gives a fair indication of what may be hoped for in this method."

No. 11.

ASH GRAY PINION—*(Lithophane antennata)* — *Diagnosis:* Young apples, also the buds of roses, are sometimes bored into by light green, white-striped and spotted worms. The hole penetrating the fruit or buds is about one-fourth of an inch in diameter. The fruit is often killed; and, in the case of injury to rose buds, the petals are either conspicuously perforated, or fall as soon as the bud opens.

Bulletin No. 9, of this Station, contains an account of this insect injuring roses in 1890, in which year it was exceptionally injurious to roses about Reno. Since that time the larvæ have been found, a few each year, on the apple and on rose bushes. It has not, however, seemed to do material injury.

The larvæ are to be found, usually, hidden among the leaves, near the point of feeding. The following description of the larvæ is taken from the above cited bulletin:

"The full grown larva is about one and three-eighths inches long, cylindrical, free from hairs, and presents a light-green colored background. Many creamy-white spots are sprinkled over the body, which bears a narrow but distinct creamy-white dorsal line, and a somewhat wider one along each side. These lateral stripes are widest at the posterior end of the body. Midway between the lateral and dorsal stripes is a distinct line of white spots and below each lateral stripe is a somewhat broken line of the same. The anterior dorsal margin of the first segment back of the head bears a white collar."

The moth developed from the larva has a wing expanse of about one and one-half inches. The front wings are ashy gray, the hind wings brown. It flies at night and is rarely seen.

It is not probable that this insect will cause sufficient damage to call for especial consideration other than the shaking of the bushes and forcibly spraying them with water.

No. 12.

CURRANT STEM BORERS—*(Sesia tipuliformis, Chrysobothris femorata)*—*Diagnosis:* The stalks of the several kinds of currants, also those of the gooseberry, are frequently found bored longitudinally along the pith for the distance of several inches. The cavity is ordinarily filled with fine sawdust-like excrement and chips. This material is commonly black, or dark colored at least, and wet from the presence of sap. In autumn or spring, a light colored worm is usually to be found at one extremity of the cavity. Occasional holes the size of the tip of a pencil are to be found penetrating the bark and wood to the cavity. The stalks appear unhealthy, and are often broken down by the force of the wind.

Both of these insects have been found infesting the currant in Reno. Though widely different in character, the mode of injury to the stalks produced by these insects is essentially the same.

The first mentioned, *Sesia tipulifomis*, is a small and beautiful "clear-winged" moth in the mature stage. Owing to its foreign origin, and its preference for the currant and gooseberry, it is known as the Imported Currant Borer. It is rarely seen except by the entomologically inclined, who may see it on bright June days flitting about the currant bushes. The eggs are laid upon the stems in June. The young larvæ produced from these eat their way into the stem, a single one in a place. On reaching the pith, they burrow through it lengthwise of the stem, often for the distance of several inches. In this way they spend nearly a year attaining their growth. In autumn or spring, these larvæ are yellowish tinged, the head and front legs brown. In early June, they emerge from a light brown chrysalis case which often projects from the hole in the stem.

This insect is very common in Reno, as it also is throughout most of the United States. It has been said that the insect destroys no more stalks than is good for the bushes. However, the gardener might prefer to do his own pruning.

The application of washes is not adapted to lessen the work of this insect. On learning to recognize the infested stalks, the gardener can trim these out, cutting below the point of infestation. If the work is done in late spring, the infested stalks should be distinguished easily. They should be burned.

The other insect infesting the currant stems in a similar manner in Nevada is the well known flat-headed apple tree borer, discussed more fully under this title (No. 1). As a currant enemy, this insect is far less common than the preceding. The writer has found it in currant stems in a few instances only.

The presence of this insect may ordinarily be distinguished from that of the imported currant borer, by the fact that the infested stalk is usually burrowed beneath the bark which may crack and fall away. The broad, flattened portion of the body just back of the head serves to distinguish this larva from the other.

Cutting away and burning the infested stems in spring would be generally beneficial to the plants. This would not materially reduce the likelihood of future infestation, because of the greater prevalence of this insect upon various trees. A thorough coating of strong soap given the bushes in spring would probably be an effective preventive of injury to these plants.

No. 13.

CABBAGE PLUSIA—*(Plusia brassicæ)*—The leaves of the cabbage are injured in a manner very similar to that caused by the imported butterfly, by the larva of a night-flying moth, the cabbage plusia. *Diagnosis:* Irregular holes in the leaves, and others penetrating the head, are produced by a pale green larva having faint longitudinal stripes and the somewhat peculiar habit of looping up the body when walking. The larva is an inch or more long at maturity, when it seeks some sheltered spot, as between two leaves or on the under side of the broad leaves near the ground, where it spins a thin, frail cocoon nearly three-fourths of an inch long. From the pupa formed within the cocoon, there develops a moth whose wings expand about 1½ inches. The front pair are grayish brown with more or less distinct markings and an irregular silvery spot near the centre, the hind wings brownish.

This insect is to be found on cabbage plants about Reno each year, but has not, as yet, produced serious injury. Many of the pupæ are destroyed by a blue four-winged fly.

The remedies employed against the imported cabbage butterfly will act upon these larvæ, thus destroying them without their being given special attention.

No. 14.

CORN EAR WORM – *(Heliothis armiger)—Diagnosis:* Sweet corn raised in western Nevada is very generally injured by a greenish or brownish striped worm which gnaws the kernels, chiefly about the tip of the ear. The injured portion of the ear is discolored, contains considerable brown, wet excrement, and is frequently mouldy. One or several worms may occur in a single ear. In the latter case, they ordinarily vary in size.

Every consumer of sweet corn in this region is somewhat familiar with this insect in the larval stage. The parent insect is a moth, olive-green or light brown in color. Her eggs are laid at the tip of the growing ear, the young larvæ eating their way in to the kernels. When full grown, each larva leaves the ear and passes into the ground where it forms a pupa a short distance beneath the surface. It is probable that two broods repeat this operation annually in western Nevada. The pupæ of the second brood remain in the ground during winter.

This is a difficult insect to combat owing to the character of its injury. Many moths can be destroyed by sweetened poisons placed in the garden. Preventing the maturity of the worms infesting the earliest corn, will greatly reduce the extent of the later injury. Late plowing, followed by harrowing, of ground upon which corn has been grown will destroy many pupæ.

In certain parts of the country, tomatoes have been seriously injured. Only occasional instances of this has been noted here. This is the very injurious Boll Worm of the cotton states.

No. 15.

ZEBRA CATERPILLAR—*(Mamestra picta)—Diagnosis:* Among other more common larvæ feeding upon the leaves of the cabbage, may occasionally be found very pretty caterpillars having bright markings in black, white and yellow. They are black along the back, with stripes of yellow on the sides, separated by a band of black having numerous irregular cross lines of white. The head and legs are reddish. When full grown, these larvæ are nearly two inches long.

The parent moth has beautiful purplish brown front wings, the hinder wings being nearly white.

The young larvæ, which are at first nearly black, and later pale green, feed in clusters on the leaves; so, if the plants are watched and such clusters of insects found, their removal will greatly lessen future injury by this insect. The remedies employed against the imported cabbage butterfly will also destroy this insect.

No. 16.

CUT-WORMS—(Various species) — *Diagnosis:* Various transplanted plants and hill growing crops are injured by cut-worms which gnaw off the plants. Wilted, fallen plants indicate the presence of these insects.

Most people are somewhat familiar with the cut-worms which are the larvæ of a large group of night-flying moths.

Only a few statements respecting those of their habits upon which remedies are based are given here. Like the moths which they produce, the cut-worms which injure garden and field crops are nocturnal in their habits, remaining hidden, often under ground, during the day, coming to or upon the surface at night to feed. Young vegetation, either fresh or wilted, is suited to their taste. Thus it is that so many young plants are destroyed by being cut off at, or just beneath, the surface of the ground. On digging about the base of a plant that has been very recently cut off, one or more of the cut-worms usually may be found.

The placing of poisoned bait at intervals upon infested ground has proved one of the most effective methods of destroying the cut worms. Any easily obtained succulent vegetation is sprayed with strong Paris green or London purple water and then placed in small bunches on the infested ground. On coming forth at night, the worms are attracted to this seemingly well prepared food, with the desired result that great numbers of them are fatally poisoned. Alfalfa would serve as a good bait material. It should be sprayed while standing, then mowed and distributed a handful in a place, in the vicinity of the infested plants, the bunches being placed a few feet or yards apart.

No. 17.

DIAMOND-BACK MOTH—*(Plutella cruciferarum)*—*Diagnosis:* Cabbage leaves are frequently perforated or show spots on the surface where the tissue has been eaten away, leaving only the thin, translucent, parchment-like skin of one surface of the leaf. Further examination of the leaves is likely to reveal the presence of some small, light-green worms about a third of an inch long, if full grown, and tapering somewhat toward each end, the presence of the hind pair of legs giving that extremity a somewhat forked appearance. If disturbed, the larvæ wriggle actively and drop, hanging suspended by a silken thread. Upon the surface of the leaves may be found the little cocoons of this moth, each about a third of an inch long and consisting of a frail net of white fibres encircling the pupa.

This little insect is found in many parts of the United States and in many foreign countries. In England it has utterly ruined turnip crops. In some parts of this country it has been reported as very injurious. It has not thus far become sufficiently injurious in Nevada to attract popular attention, yet it seems to be generally present in the cabbage fields.

The moths developed from these small larvæ are about one-third of an inch long exclusive of the feelers, which, when the moth is at rest, are held together and project out in front of the insect's head. The wings are slender, grayish, usually with a white stripe, a part of which belongs to each wing, along the back.

The various transformations are passed very quickly which results in a succession of broods each season.

Since this insect is not, as yet, especially injurious it probably will not receive particular attention from gardeners. The application of the remedies for other more serious cabbage insects, whose periods of activity are the same as that of this insect, will doubtless keep this one within the limit of injurious numbers.

No. 18.

SNOWY TREE-CRICKET—*(Œcanthus niveus)—Diagnosis:* The stalks of raspberry, blackberry, and the rose, often present narrow longitudinal roughened stripes on the surface of the bark. These roughened stripes are commonly discolored, and frequently show a row of punctures or a split in the bark or wood. They may be straight or curved, and vary from half an inch to two or three inches in length. Shaving off a scarred strip, cutting into the wood slightly, discloses a row of perforations each the size of a pin. Splitting the stem through the perforations, shows them to be slightly curved and to extend to, or into the pith. If the punctures have been recently made, each will contain a yellowish white egg; otherwise only the empty shells will be found.

The insect which causes this injury is popularly called a tree-cricket. It spends the latter part of summer and autumn among shrubs and trees, the males being responsible for much of the chirping heard on warm nights. Each sex is somewhat less than an inch long, with longer thread-like feelers. Both are greenish white. The wings of the male lie flat on the back, those of the female being folded about the body, which is tipped by the slender piercing organ with which the egg punctures in the twigs are made.

The eggs hatch in spring, the young insects feeding during summer upon plant lice found upon, or in the vicinity of, the plants in which they passed the egg stage. In the latter part of summer they reach maturity and in autumn eggs are deposited for the insects of the following year. Thus the insects are both beneficial and injurious.

Cutting out and burning infested branches in late autumn, winter or spring is about the only effectual remedy.

No. 19.

PLANT LICE—*(Aphis spp.)*—The plant lice are the commonest of insects, innumerable species living upon plants grown both indoors, and out. *Diagnosis:* They are soft bodied insects, the commonest greenish in color, an eighth of an inch or less in length, the legs long and slender as are also the feelers. A pair of commonly slender horn-like tubes project from the back at the hinder extremity of the body from which drops of transparent sweetish liquid exude, frequently in considerable quantity.

Their feeding and injury producing habits are accomplished by sucking the sap of the plant through a slender beak with which they pierce the skin of the leaf or stem they infest. They are mostly wingless, but some of each kind develop wings which aid in their dissemination. Eggs are produced in late autumn, but some mature individuals hibernate during the winter. They are easily killed but, seemingly, do not readily "stay killed", for, owing to their wonderful powers of reproduction, they are apt soon to appear again as numerous as ever. They have numerous enemies in predaceous insects some of which aid greatly inreducing their numbers. Prominent among these insects, are the lady-bird beetles or "lady-bugs." Ants so frequently seen among them are there to obtain the sweet "honey dew" which exudes from their bodies.

Bulletin No. 11 of this Station treats briefly of these insects and some of their natural enemies in connection with those that infest the apple.

Several recognized groups, and even more genera, of the plant lice occur upon valued plants in our region. To attempt to designate these by their technical characters would be folly in an article of this kind, but the habits of some of them, briefly stated, cannot fail to make their recognition possible.

No. 20.

APPLE LEAF LOUSE—*(Aphis mali)*—*Diagnosis:* The leaves of the apple, particularly those at the ends of the branches of young trees, are frequently found to curl backward, becoming dwarfed and shriveled. Great numbers of green plant lice will be found on the under surface extending frequently down the leaf stalks to, and upon, the twig. The twigs become stunted and often deformed, bending abruptly sideways. During the preceding winter the terminal twigs of these trees were probably well stocked with small shining black eggs clustered about the buds and scattered over the bark. These were the eggs of the lice which swarmed upon the leaves as soon as they began to form.

Here, the injury caused by these lice seems to be confined principally to young trees, where the worst results follow the injury to the opening leaf and flower buds. The great number of insects in the first broods often permits the young leaves and stems to be almost wholly covered by them. At this time most effective work could be done by spraying the tree with kerosene emulsion, strong soap suds, or tobacco decoction. Later, the more dense foliage and the curled condition of the infested leaves protects the lice to such an extent that many of them would not be reached by the spray.

These lice are subject to a disease, probably of bacterial nature, which destroys a great many of them in the latter part of summer. The disease causes them to shrivel and assume a dark brown color, their bodies remaining attached to the leaf.

No. 21.

WOOLLY APHIS—*(Schizoneura lanigera)* — *Diagnosis:* (1.) The most conspicuous, and usually most evident, character by which this disease may be recognized in Nevada, is the presence of white cottony or woolly masses upon the trunk, especially at points of injury, upon young growth as "sprouts," and upon the branches, particularly in the leaf axils.

(2). The effect of the root-infesting form is to kill the tree without the true cause being clearly evident. The tree's usually slow death becomes evident in the reduced number of leaves which assume a light green or yellowish color. In the advanced stage of the disease, the tree is liable to be blown over by a strong wind, breaking off near the crown. On removal of the earth about the trunk, the roots of the infested tree exhibit a knotted appearance, unnatural excrescences of perhaps dead and decaying tissue taking the place of the natural healthy root. If these roots are still alive, the bluish-white mouldy appearing lice may be found abundant, actively engaged in deforming and destroying the roots.

As Bulletin No. 17 of this Station is devoted to this insect, but a short general account including information on recently demonstrated remedies is here given:

The insect is a specific kind of plant louse which confines its attack to apple trees of all varieties. Immense numbers of the young are developed during the seasons of spring, summer and autumn. From eggs developed in late autumn, each remaining within the dead and shriveled body of a louse resting in a crevice of the bark, young are hatched in early spring. In some climates, such as prevails in Nevada, many of the lice live over the winter, reviving with the coming of the first warm days. During the hibernating period, little if any of the white woolly covering is evident. With the return to activity, however, this covering is developed and the depleted colonies of the preceding season become evident. These persist throughout the season, developing toward its close, winged individuals devoid of cottony covering.

The observations of a number of years confirm the belief that the woolly aphis is a thoroughly well established and seriously destructive enemy to the apple industry of Nevada. Our climate is in every respect most favorable for the existence of the disease. It is so common that in many orchards unaffected trees cannot be found. Often the twigs and limbs are conspicuously scarred. In some instances the limbs exhibit knotty outgrowths the size of the fist and smaller.

The remedies stated on page 7 of Bulletin No. 17 are still in force and generally recommended. Experiments by Prof. J. M. Steadman in Missouri, Bulletin No. 35, Mo. Exp. Sta., 1896, show the efficiency of tobacco dust, employed against the root form of this insect, and of carbon bisulphide in killing insects already established. We cannot do better than to quote from the summary of results given in the bulletin cited:

"Apple seedlings, buds and grafts should be planted in a small trench filled with finely powdered tobacco or tobacco dust and lightly covered with earth. This will keep the woolly aphis away.

"Apple nursery stock should have a liberal supply of tobacco dust applied to the roots every spring in order to kill the woolly aphis and prevent it from establishing itself there. It should be applied by removing some of the earth from around the roots, filling the excavation with tobacco dust, and lightly covering it with earth.

"In planting apple trees, tobacco dust should be freely used among and over all the roots, and close around the trunk, in order to kill and prevent the woolly aphis from establishing itself there.

"Every spring, as soon as settled warm weather appears, each tree should have a liberal supply of tobacco dust applied to its roots by removing the earth from around the trunk for a distance of two feet, and four inches in depth, evenly filling this with tobacco dust and covering it with earth.

"The root form of the woolly aphis may be cheaply and easily killed and kept away from an apple tree by the liberal use of tobacco dust. About 5 or 6 pounds of this substance should be applied as above directed to the roots of every infested tree, and one-half this amount should be applied in a similar manner each succeeding spring, costing approximately two cents per tree per year.

"This insect may also be destroyed by injecting one fluid ounce of carbon bisulphide two feet away from the trunk on two sides of the tree, but the use of this substance is not advised except in extreme cases, since a little carelessness may injure the tree, and it is always necessary to immediately treat the trees with tobacco dust to keep the insect away."

No. 22.

THE CABBAGE LOUSE—*(Aphis brassicæ)*—*Diagnosis:* The insects belonging to this species are very injuries to the cabbage crop in western Nevada. The lice collect on the lower side of the outer leaves of the cabbage, and more or less, upon both sides of the young leaves of the forming head. The outer leaves curl or bend backward, become light colored or yellowish, and finally wilt and die. Those about the head are effected in a similar manner; and if badly infested, as they often are, the head does not form at all.

The lice differ from others commonly seen, in having the body covered by a fine whitish dust or bloom. They may be found in colonies here and there on the surface of the leaf, or so thick as to be closely crowded. They may be found on the plants very soon after setting and thereafter until the crop is harvested, becoming more numerous as the season advances.

The work of controlling this insect commences, properly, with the gathering of the crop in autumn. At this time the land should be thoroughly cleaned of all refuse cabbage plants, such material being burned; especially if the same ground is to be used for cabbages the following season. The object of this is to destroy many insects that would otherwise remain alive over winter, also eggs deposited by the last brood in autumn. Refuse of turnips, radishes, cauliflower, yellow mustard, and all weeds of a similar nature should likewise be destroyed, as the lice will feed upon these if no cabbages are to be had.

Spraying the plants with kerosene emulsion, strong soap suds, or tobacco decoction will destroy the lice; but the treatment has to be repeated as soon as the lice re-appear, as they are almost certain to do, to some extent at least.

Spraying should be done when the first evidence of the presence of the lice appears. The value of the crop and the success of future spraying is very dependent upon the thoroughness with which the first work is done. "Sprinkling" the plants with the best remedy is of little use. A "Cyclone" nozzle attached to a bamboo "extension," the nozzle throwing at right angles to the extension, is probably the best for this work, since both sides of the leaves can easily be reached by the liquid. Later in the season many old and mostly useless leaves lie on the ground securely protecting many of these lice as well as other insects injurious to the cabbage. These leaves may profitably be removed in advance of spraying.

By mixing buhach or white hellebore with the keroscene emulsion, other insects, notably the larvæ of the white butterfly, *Pieris rapæ*, can be destroyed also.

In field experiments, conducted by this department, in which it was desirable to destroy both of these insects, it was found that neither the keroscene emulsion, the buhach, nor white hellebore, when used alone, accomplished the desired end. The combination of either buhach or white hellebore with the emulsion at the strength of 1-16 oz. of the powder to one gallon of the emulsion prepared for use, resulted in the destruction of both insects.

The exposed condition of the cabbage lice leads to the destruction of great numbers of them by predacious and parasitic insects; and the various forms in which these friendly allies appear should not be mistaken by the gardener when seeking the destruction of the injurious kinds.

No. 23.

PLUM LEAF LOUSE—*(Aphis prunifolii)*—In a few instances, plum trees have been noticed to be affected by mealy-bodied plant lice very similar in general appearance to the cabbage lice. In the cases cited, the insects seemed to confine themselves exclusively to the lower surface of the leaves which, in some instances, they completely covered owing to their great number. Active treatment with the proper remedy, using a "Cyclone" nozzle with side discharge permitting the under side of the leaves to be reached easily, should enable one to rid the trees of this insect.

No. 24.

ROSE PLANT LOUSE—*(Aphis sp. ?)*—During summer, rose bushes are frequently seriously infested by plant lice. One species commonly found about Reno is brown in color thus noticeably different from those commonly seen. *Diagnosis:* This species has been found in great numbers literally covering the young growth of stems and leaves at the ends of the branches, giving the plant an unsightly appearance, and doubtless doing it material injury by the withdrawal of much nourishing sap.

Persistent use of a spray of keroscene emulsion, soap water, or tobacco decoction would rid the bushes of these insects.

No. 25.

CURRANT LEAF LOUSE—*(Aphis ribis)*—*Diagnosis:* The leaves of the currant are very generally affected by a plant louse which feeds in colonies on the lower surface of the leaves. The leaves at the end of the stems seem to be affected worst. They curl backward, and, owing to their proximity, clasp about each other more or less, thus forming a conspicuous protective shelter for the insects clustered beneath. Frequently the leaves assume a knotted appearance on the upper surface due to the almost gall-like protuberances caused by the lice.

Suitable spraying or dipping the ends of the stalks should destroy the lice.

No. 26.

Elm Leaf Louse—*(Aphis sp. ?)*—A certain plant louse infests the American elm affecting some of the leaves in much the same manner as are those of the currant just described. The dwarfed and curled leaves form close clusters several inches long, usually involving nearly or quite all the leaves of a twig. A great number of insects are protected by the cluster, which, if shaken, gives forth a shower of drops of honey dew.

The American elms about Reno are very commonly affected by this species, the clusters of affected leaves being scattered here and there over the trees. With the fall of the other leaves in autumn, those of the clusters turn brown but remain fast to the otherwise bare limbs during winter.

Cutting off the infested branches in summer, would perhaps be as practicable a method as any to follow where the trees are no more seriously affected than are those thus far observed.

No. 27.

Cottonwood Leaf Louse—*(Aphis sp. ?)*—One species of plant louse is very common on the leaves of the cottonwoods. They are found on the young twigs also. In the latter part of summer these lice frequently become very numerous. The sweetish liquid which they secrete in considerable quantity is caught by the leaves giving them the appearance of being wet. Insects are attracted and dust caught by this substance giving the tree a very disagreeable appearance.

No. 28.

Poplar Leaf-Gall Louse—*(Pemphigus sp. ?)*—Another plant louse produces the gall-like swellings frequently found on the stems of the leaves of the cottonwood. These galls (see illustration Bull. No. 11, Nevada Exp. Station, p. 3) are enlarged and twisted portions of the leaf stems the size of a marble, lying between the blade and the junction of the leaf with the stem. They are hollow, a partially open slit along one side leading to the interior. On opening the gall, one large parent louse and many small ones are found within, lying among many globules of transparent liquid and the whitish cast skins of the young lice.

No. 29.

WILLOW STEM LOUSE—*(Lachnus sp.-?)*—One of the largest of the plant lice often attracts attention as occurring on the willows, both the common wild shrubs, and the cultivated tree of which there are a number of specimens about Reno. These insects, which have red bodies, are to be found in clusters containing from a few to several hundred individuals; resting on the trunk, branches or twigs of the willows. A blood red liquid results from crushing the bodies of a colony of these insects, a fact frequently the subject of comment on the part of non-entomological observers.

No. 30.

SCALE INSECTS OR BARK LICE, ETC—This group contains many of the most injurious of the insects. Because of the fact that these insects in many instances are protected by a scale-like covering consisting of the dried body wall, moulted skins, or secretions from the body of the insect, the term scale insects has been applied to them. Furthermore they are essentially bark infesting, though they often occur on the leaves and fruit also.

Of the several representatives of the group that occur upon domesticated plants in Nevada, the San Jose Scale is the most destructive.

No. 31.

SAN JOSE SCALE—*(Aspidiotus perniciosus)*—*Diagnosis:* The presence of the San Jose Scale insect is manifest in a number of ways including its appearance upon the plant or fruit, or the effect it produces upon them. As a disease of the orchard, it may be recognized at a distance of a few yards or even rods by the ashy-gray aspect of the lower part, at least, of badly infested limbs, which replaces the normal clear color common in young trees. If these limbs have died within the growing season after the leaves have formed, the conspicuous brown dead leaves persistently remain, even over winter. Closer examination shows the surface of the bark to be somewhat roughened. Rubbing with the nail produces a yellowish oily moisture, resulting from the crushed bodies of the insects. Scraping the bark with a blade shows it deeply reddish purple colored within. The twigs show the scales usually scattered, their form more or less distinctly outlined against the bark. Often the surface about the scale is depressed and dark or purplish colored. The leaves, when the scales are numerous, become lighter colored, often yellowish, the portion immediately about the scales darker; brown dead leaves persisting long upon the branch. Fruit, infested to any extent, either in the orchard or on the market, may be easily recognized. Light skinned apples and pears become reddish purple about the scales giving them a suspicious spotted appearance. The individual scales often appear distinctly outlined against the dark skin of plums. Infested fruit is, furthermore, liable to be dwarfed, deformed, and often cracked, decaying easily.

Bulletin No. 29, 1895, of this Station, contains a preliminary account of this insect in Nevada which it is unnecessary to report here. The two years since the publication of that bulletin, have fully confirmed its closing statement respecting the serious aspect which the disease presents in Nevada. Within this period many new localities of infestation have been located within the Truckee Valley. Its presence in a grave degree at Hawthorne, in Esmeralda county, has been demonstrated by infested material received from an orchard located there. Orchards which two years ago contained but a tree or two showing scales, are now very generally infested. While the writer does not recall having seen entire trees dead evidently from this disease, trees in which from one to several limbs have succumbed to the disease are of frequent occurrence. Badly infested locally grown fruit is to be found in the market.

Aside from the above cited bulletin, two press bulletins have been issued, one on Sept. 30, 1896, the other on Sept. 4, 1897. Altogether, three parties have applied to the department for suggestions as to the care of their orchards, and a possible half dozen people are known to the writer as contemplating doing something to check this destroyer of fruit trees. But greater activity on the part of orchard owners than this, will prevail before any marked improvement in the present condition of the San Jose Scale problem in Nevada becomes manifest.

Respecting practical work performed by the Experiment Station, it may be said that much remains to be confirmed. It is hoped a part of this will be accomplished the present winter.

An account of the first work in this direction by the Station was given in press bulletin No. 20, issued Sept. 30, 1896, from which the following is quoted:

"On May 9, 1896, some very badly infested apple and plum trees were sprayed with a strong wash of whale oil soap (2 pounds of soap to 1 gallon of water). But a single application was made. Especial care was taken, however, to thoroughly wet all parts of the trees, which end seemed to be secured, excepting, possibly, the ultimate branchlets. The work was done later than was desirable as the leaves had already appeared. The leaves were badly crumpled and shriveled by the wash, which condition they have maintained during the season. The younger leaves which had not expanded have presented a most healthy appearance, in sharp contrast to the contorted leaves of early spring.

"Observations upon the insects made within the following fortnight, failed to disclose any living insects where myriads existed before treatment. The real result was expected to appear later in the season when the young of any survivors should make their appearance. Careful examination of these treated trees at the present date shows the scales loosened and falling away, with only an occasional living insect to be found. A few scales are to be found on the leaves from the outer branchlets, which shows that the wash was least effective at these branchlets.

"Notwithstanding the absence of complete success, the result was better than was expected, and gives promise of even better success in experiments to be pursued during the coming winter"

On December 8th, 9th and 10th, 1896, further spraying was done in the same orchard where the work of May 9th was performed. Whale-oil soap at the strength of two pounds to a gallon of water, was used. As before, the soap and water mixture was used while nearly boiling hot in the pail from which it was pumped. Besides spraying several trees not previously treated, two or three of those sprayed in May were again sprayed as thoroughly as possible. The weather remained clear and bright, with freezing at night for a week or more following the spraying. Examination of the sprayed trees a few days after treatment showed the scales loosened the insects beneath brown and shriveled. Examination of all the trees treated, in Sept., 1897, nine months later, when in fruit, showed the real results most clearly. One apple tree, badly infested when sprayed in May '96 and not sprayed in Dec. '96, showed scattered healthy scales on all parts including the leaves. A plum tree thickly coated with the scales in May, sprayed then, and again in December, was seemingly completely freed of the insects. An old pear tree pruned back nearly to the trunk bearing a number of young shoots, badly affected and sprayed first in December, showed but a trace of living insects. Other trees ten or fifteen years old, in an otherwise healthy condition, but badly incrusted with scales in December, when they were sprayed for the first time, showed no living scales on the trunk, lower limbs and branches. A few scales were found on the terminal branchlets. From these, scattered colonies of scales had formed on the fruit and leaves. It seemed evident that had these trees been cut back at the terminals before spraying, the single treatment in December would have nearly, if not wholly, freed them of scale insects.

The lime, sulphur, and salt wash employed in California has not been experimented with by this Station. Early in the spring of 1897, the writer assisted in the application of such a wash, in an orchard in Reno. He did not witness any of the steps in the preparation of the wash and cannot speak authoritatively upon this all important part of the work. The spraying of a number of very badly affected trees was thoroughly done, going over them twice in order to wet all parts of the trees. Examination three months later showed that while some of the insects might have been killed, too many remained to justify the labor and expense of spraying. The leaves and fruit were seemingly as badly infested as though no spraying had been done.

A short summary of the San Jose scale problem gathered from various sources, particularly from "The San Jose Scale, Its Occurrences in the United States," a publication from the U. S. Department of Agriculture, by L. O. Howard and C. L. Marlatt, 1896, would embrace the facts that the San Jose scale is considered the worst insect enemy of the deciduous fruits known; that it is very rapidly spreading to all parts of the country; that it does not yield uniformly to the same methods of treatment in different parts of the country having different climatic conditions; that successful methods in vogue in California do not give satisfactory results in the east; that the methods most likely to prove effectual in Nevada will probably prove to be more like those employed in the east than in California, and that until other methods now frequently recommended are demonstrated to be adapted to more general application, the winter wash of whale-oil soap properly applied, at the proper strength, is the most reliable.

It will be noted that whale-oil soap has been employed in the experiments of this department at the single strength of two pounds of soap to one gallon of water.

Experiments by the Division of Entomology, U. S. Dept. of Agriculture, in which three pounds of whale-oil soap to one gallon of water were used resulted fatally to all the insects. With two pounds of soap to one gallon of water, all the insects were killed in one case, and 95 per cent in another. With less than two pounds to the gallon, not all were destroyed in any instance. In an experiment with pure kerosene oil upon two apple trees in January the insects were all killed, as were the trees also by the following spring.

A fungus disease of the San Jose scale in Florida is reported upon at length by Prof. P. H. Rolfs, in Florida Exp. Sta. Bull., No. 41, 1897. Though this disease is widely distributed geographically, it is not probable that it would prove effective in Nevada, owing to the dry climate.

Various predaceous insects destroy many of the scales in certain parts of the country. Of these, a hemispherical "Lady-bug" *(Chilocorus bivulnerus)*, shining black with two red spots on the back, has been observed by the writer as feeding upon scale insects here, both the San Jose scale and the English walnut scale.

No. 32.

ENGLISH WALNUT SCALE—*(Aspidiotus juglans-regiæ)*—*Diagnosis:* Boxelder and cottonwood limbs and branches are killed by this insect. The branches assume a spotted appearance, due to the diseased condition of the bark, and finally die. While still alive, the young branches are green colored, or even darker from the discoloration of the disease. Then the light colored scales of the insect are easily distinguished against the darker back ground. The female scales are irregularly circular, larger than those of the San Jose scale, raised toward the eccentric axis, light gray colored, a darker band surrounding the axis, which is brick red or light colored by the presence of a thin covering. The scales are often much crowded, a mature female scale frequently covering several half grown scales. In the case of older branches that have been killed, the bark having faded, the dead scales are hard to distinguish except by the scurfy condition they produce. From such branches they loosen and fall readily.

This insect has not become conspicuously injurious here as yet. Boxelder and cottonwood trees in different parts of Reno are affected. Individual limbs have succumbed to their attack while the remainder of the tree shows no signs of their presence.

While no experiments have been made with remedies for this insect by the department, it is quite probable that the remedies for the San Jose scale would prove effective against this species. Like the San Jose scale, this species occurs on a number of different plants.

No. 33.

OYSTER-SHELL BARK LOUSE—*(Mytilaspis pomorum)*—*Diagnosis:* The bark of various trees infested by these scale lice presents a spotted appearance, the spots being the lice and their egg protecting scales. These are about an eighth of an inch long, rounded on the back, pointed at one end, becoming broader towards the other end which is rounded, and are either straight or curved. The color is brownish, the body proper forming the pointed extremity. Their conspicuousness is dependent upon their number and the color of the bark on which they are found. They may occur scattered over the bark or so closely crowded as to overlap one another, considerably modifying their size and form. These are the mature female lice which attain maturity and die in August. The larger brown portion of the scale then contains a great number of eggs, easily seen on over-turning one of the scales. The eggs hatch in May or early June, the young lice scattering over the bark. The old dead scales remain fixed to the bark for a long time without material change still covering the empty shells of former eggs.

This has long been a well known insect in the east and central west where it has been a generally recognized pest of the apple. It occurs also upon other fruit trees and shrubs, also upon various ornamental trees.

It has not thus far been found on fruits in Nevada. It has been taken by the writer, however, on the Lombardy poplar in the streets of Carson City. This was in September, 1896. A number of these trees in one locality are thoroughly infested.

Owing to the preference of the insect for the apple, demonstrated in the east, we may reasonably expect it to eventually become an apple pest here, particularly since it is already well established within our State in at least one locality and possibly in many others.

This insect should not prove difficult to control. Spraying whale-oil soap upon infested trees in late autumn should so loosen the scales as to result in fatal exposure of the eggs to the winter's dampness and cold. Kerosene emulsion or strong soap mixture employed in spring immediately after the young have appeared should prove effective.

No. 34.

LECANIUM BARK LICE—These insects occur on a number of trees and shrubs in our region and possibly represent several distinct species. They are sufficiently similar, however, to be characterized together. *Diagnosis:* The Lecanium scales are most frequently met as reddish or dark brown, flattened, saddle-shaped, or hemispherical bodies, from one-eighth to one-quarter of an inch in diameter, attached to the branches or stalks of trees or shrubs. Old dead scales are brittle and fall away readily, exposing the empty egg-shells as a whitish dust beneath. Early in summer the young may be seen slowly moving over the bark in the vicinity of the old scales.

The locust trees about the streets of Reno, while seemingly not evidently affected by these insects, often exhibit them in immense numbers closely crowded upon the branches on the lower side causing them to present a conspicuously knotted appearance

Lecanium ribis is frequently found here on the stalks of the currant and gooseberry, yet not in sufficient numbers to do evident damage, however.

Whale-oil soap spray of good strength applied early in the season when the young lice have hatched would doubtless be found an effective remedy. It may be stated that a parasitic fly destroys many of them, living within the body of the insect, and leaving a hole the size of a small pin at the point of its escape from the body wall.

No. 35.

COTTONY MAPLE SCALE—*(Pulvinaria innumerabilis)*—This insect is closely related to the Lecanium scales from which it differs conspicuously in the presence of a cottony egg mass larger than the scale proper. *Diagnosis:* Boxelder trees exhibit this insect upon the branches. The body of the insect proper forms a somewhat flattened, oblong, saddle-shaped object, reddish brown in color, and nearly an eighth of an inch long. Out from beneath one end of this there projects a white cottony mass two or three times the size of the insect proper. This protects a mass of minute creamy eggs in summer. If pulled out it presents a stringy appearance.

Only the boxelder seems to be infested here, though elsewhere its near relative, the maple, is commonly infested, as is also the grape.

No. 36.

IMPORTED ELM BARK LOUSE—*(Gossyparia ulmi)*—*Diagnosis:* Infested elm trees exhibit dirty grayish rows and patches of old dead insects and their secretions along the lower side of the branches, evident for a distance of several feet or yards from badly infested trees where the disease has been in progress for two or three years, or longer. Closer examination shows the shriveled dark brown bodies of the insects to be about an eighth of an inch long, each surrounded by a cup of whitish or dirty gray waxy material, and often many white oblong cocoons a sixteenth of an inch long intermingled with the others. Cracks in the bark are often thickly covered by the bodies of the insects. On smooth bark, they occur in patches, especially about the base of the branches.

The foregoing condition is most evident in autumn. At this time, many of the young are distributed over the leaves. Later they return to the branches and may be found clustered, as above stated. In late autumn and early spring they appear as minute gray objects which move about sluggishly when disturbed.

Trees long affected are likely to show dead branches and in this way, perhaps, give the first intimation of the presence of the disease.

A further statement of the nature of this insect and its life-history is to be found in Bulletin No. 28 of this Station, which gives an account of the discovery of the insect at the Capitol grounds at Carson City.

No new infested locality has been discovered since that described in the above cited bulletin.

Following the suggestions offered by this department, Mr. C. A. LaGrave, State Comptroller, had the elm trees on the Capitol grounds thoroughly sprayed in March, 1896. The wash employed consisted, essentially, of a kerosene emulsion containing, as prepared for this particular occasion, 3 pounds of whale-oil soap, 6 gallons of kerosene emulsified in 3 gallons of water, then diluted to form 45 gallons of the mixture.

A bundle of infested branches sent to the writer a few days after treatment, failed to show a single living insect, while thousands had been killed by the emulsion. A careful examination of the trees by the writer in the following September resulted in his inability to find a sufficient number of the insects of the brood of 1896 for study. Later, however, some living insects were found and sent to the department for examination. That some, or even many, should have escaped the treatment is not surprising when the size or the trees, which were mostly 40 or 50 feet high, and the probable inexperience of the workmen, are taken into consideration. The results may be considered very satisfactory as showing what may be expected from this mode of treatment under favorable conditions.

This insect has not yet become generally distributed throughout the country, but to show that it is important to keep it under control, it may be stated that it has been reported from several points within the United States. Prof. G. H. Perkins states in the annual report of the Vermont Agr'l Exp. Sta., for 1889, that this is one of two or three insects that "have proved especially injurious" to the elm; also that it was common on the elms at Burlington. In Bulletin No. 28 from the Mass. Agr'l Exp. Sta., 1895, Mr. C. P. Launsbury states that this insect had become very common, also that young American elms had been almost destroyed by it. As a remedy, kerosene emulsion. only when very strong, proved effective. The emulsion contained ½ pound of common bar soap, 2 gallons of kerosene, and one gallon of water. A gallon of this was diluted to make 3 gallons of the prepared mixture.

No. 37.

ROSE LEAF HOPPER—*(Typhlocyba rosæ)—Diagnosis:* A whitish spotted condition of rose leaves, giving them a gray appearance, indicating the presence of numerous white insects feeding upon their lower surface, is very common about Reno.

These insects represent one of many kinds of closely allied insects that infest the lower surface of the leaves of numerous plants. By means of their tiny beaks they suck the nourishment from the leaves, destroying the tissue contents at the points of injury, resulting in the spotted aspect of the upper surface. When disturbed, these insects hop to an adjacent leaf so that one needs to use a little caution in order to observe them at their work.

The injury from these insects can be prevented by spraying the plants from beneath, with kerosene emulsion, or dusting them frequently with buhach or white hellebore.

No. 38.

Buffalo Tree Hopper—*(Ceresa bubalus)*—*Diagnosis:* The upper branches and twigs of young fruit trees are frequently scarred and roughened from the presence of oval slits in the bark, varying from an eighth to a fourth of an inch in length. The slits extend lengthwise of the twig, and, at first, constitute a pair of slightly incurved incisions, side by side. The bark dies at the edges of the slits which then expand, leaving, for a time, an intervening strip of bark which eventually dies and falls away. Healing begins at the sides of the slits, the young bark closing in towards the centre, the same as about the scar of an amputated branch. The surface becomes somewhat elevated in the process of healing, giving badly injured twigs a knotted appearance. Badly infested young trees soon assume a rough, scabby appearance.

This injury affects various fruit trees; the young ones most severely, the older ones being attacked principally on the younger growth; therefore the effect is not so noticeable. Various wild shrubs are also subject to injury. On the University grounds, young apple and cherry trees, willows, and a wild shrub *(Prunus Andersonii)*, are found to be severely infested.

The author of this injury is a greenish hump-backed bug, which, when viewed from above, is not unlike a beech nut in form. The female insect does the injury to the twigs in depositing her eggs, a row of which is placed in each of the two curved incisions forming a complete slit. In May and June the eggs hatch. The young insects feed upon vegetable substances during summer, maturing in August. From this time until October the puncturing of the twigs in the process of egg laying continues. The injury caused by the feeding of the young growing insects is probably insignificant as they prefer succulent vegetation, as weeds and the like; and, their numbers are, seemingly, never sufficient to permit them in this way to injure cultivated plants. Thus it is through their egg-laying habits that they become a pest of the orchard.

Judicious pruning may, in some instances, be beneficial in reducing the number of the insects. Owing to the migratory habits of the young insects, spraying is of little use.

Clean culture is the most effectual check to the prosperity of these insects. By keeping the orchard under cultivation and free from weeds, the young will be starved out and the enemy eventually driven from the orchard.

No. 39.

RED SPIDER—*(Tetranychus telarius)*—*Diagnosis:* The leaves of various trees and shrubs become spotted or turn yellowish or brownish, and exhibit a very fine web covering their under surface. Frequently minute greenish or reddish mites may be seen crawling over, or beneath, the web.

Twigs are often found covered by the webs of the mite.

In the winter and spring the eggs of the mite occur as minute globular objects in the crevices of, and beneath, scales of bark The eggs are reddish before hatching; those having hatched being represented by the white shells, intermingled with the others.

This mite is most commonly considered a pest of house-plants, as the dry air of rooms is more congenial to it than the more moist out-door air of most parts of the country.

The mite is not a true insect, being more closely related to the spiders It lives upon the sap of the plant, which it obtains by puncturing the under surface of the leaf with its very minute, piercing, mouth organs

Fruit trees, shrubs and also shade trees are very generally attacked in this region. Our long, dry summer and autumn are most conducive to the development of this pest. The browned, diseased, appearance of the leaves of fruit trees, currants and the elms is noticeable, particularly in western Nevada, during the latter part of summer and autumn. This condition is rendered the more conspicuous by the dust which these leaves, owing to their web covered surface, collect and hold, usually for a period of several weeks. During exceptionally dry seasons, this condition is likely to attract particular attention; and, it is a question whether the presence of the dust and dirt on the breathing side of the leaves is not as injurious as the direct injury of the mites.

Kerosene emulsion applied to infested plants in such a manner that the under surface of the leaves will be thoroughly wet, is an effectual remedy. Water alone, when it can be frequently applied, will often be found efficient.

SOME COMMON INJURIOUS INSECTS OF WESTERN NEVADA.

NEVADA STATE UNIVERSITY.

◆

Agricultural Experiment Station.

BULLETIN NO. 3~~5~~. 6

RENO, NEVADA, DECEMBER, 1897.

Agricultural Experiment Station.

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SOME COMMON INJURIOUS INSECTS OF WESTERN NEVADA.

F. H. HILLMAN.

INTRODUCTORY.

The following list of injurious insects is not to be considered complete, either in the number of species mentioned or in the mode of their treatment. It includes such injurious insects as are known to occur commonly in the western part of the State, and which have attracted more or less popular attention for a number of years.

By the consideration of the injuries produced by insects as plant diseases, and the especial designation of the diagnostic evidences of their injury, it is hoped that the identification of the specific nature of the disease may not be found difficult. A key based upon the principal characteristic evidences of the various kinds of injury is given as an aid in making the identifications. In using this key, the reader will be guided by the several heads and sub-heads in the order of their importance.

As a number of the insects included here have been discussed in former bulletins from this department, which are still to be had upon application, these are simply referred to, their subject matter not being repeated.

F. H. H.

January 19, 1898.

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Key for the Determination of Injurious Insects of this List.

(Based chiefly on the character of their injury.)

I. Insects affecting the larger fruits.

a. Affecting the appearance of the whole tree.

(1) Apple trees assuming a sickly appearance; the roots knotted or covered by brownish lice.

WOOLLY APHIS, NO. 21. (2).

b. Affecting the trunk and branches.

(1) Producing an ashy gray, scurfy covering on the bark, yielding a yellowish oily substance on crushing with the nail.

(Infesting fruit trees and garden shrubs generally). SAN JOSE SCALE. NO. 31.

(2) Destroying the bark and exposing furrowed, cracked, and perforated wood with more or less sawdust-like excrement.

(Infesting various fruit and shade trees.) FLAT-HEADED BORER, NO. 1:

(3) Wounds of any kind and "sprouts" bearing patches of white woolly material covering brown soft-bodied insects.

(Of fruit trees, confined to the apple.) WOOLLY APHIS, NO. 21.

(4) White cocoons ½ to ¾ inch long found in autumn and winter under scales of bark.

(Occurring chiefly on apple and pear.) CODLING MOTH, NO. 10.

(5) Minute brick-red mites often found in great numbers crawling over the branches.

(Infesting fruit trees and shrubs, also some shade trees.) RED SPIDER, NO. 39.

(6) The branches of young trees exhibiting longitudinal slits in the bark, a row of eggs under the edges of the slits; bark becoming rough and knotted.

(Both fruit and ornamental trees and shrubs affected.) BUFFALO TREE HOPPER, NO. 38.

c. Affecting the twigs.

(1) Twigs exhibiting a scurfy appearance or circular scales singly or in clusters. (See b. (1) above.)
SAN JOSE SCALE, NO. 31.

(2) Apple twigs presenting white woolly patches, particularly at the leaf axils; or, rough and irregularly scarred, insects not evident. (See b. (3) above.) WOOLLY APHIS, NO. 21.

(3) The bark exhibiting small longitudinal slits, the edges of which are dead and discolored, each covering a row of eggs. (See b. (6) above.) BUFFALO TREE HOPPER, NO. 38.

(4) Numerous small soft-bodied insects clustered on the young growth.
(Apple Leaf Louse, No. 20, PLANT LICE, NO. 19.
Woolly Aphis, No. 21.)

(5) Upper branches and twigs more or less covered by small black objects—having the appearance at a short distance of being thickly "fly-specked."
(A winter condition of Eggs of APPLE LEAF LOUSE, NO. 20.
young apple trees.)

(6) The smaller twigs covered by a very fine web containing minute red mites. (See b. (5) above.)
(Various trees and shrubs affected.) RED SPIDER, NO. 39.

d. Affecting the leaves.

(1) Leaves exhibiting minute circular or oblong scales along the veins, at least on the upper surface; also, often yellow or spotted. (See above, b. (1), c. (1)). SAN JOSE SCALE, NO. 31.

(2) Numerous soft-bodied insects chiefly on the lower surface of the leaves.
(Apple Leaf Louse, No. 20, PLANT LICE, NO. 19.
Plum Leaf Louse, No. 23.)

(3) Leaves turned brown, the foliage assuming a scorched appearance caused by small slimy worms.
(Affecting pear, cherry, PEAR AND CHERRY SLUG, NO. 2.
and plum.)

(4) Leaves with a fine web covering the lower surface and inclosing numerous minute red mites; these leaves eventually becoming lighter colored than the healthy ones. (See above, b. (5) and c. (6)). RED SPIDER, NO. 39.

e. Affecting the fruit.

(1) Apples and pears bored internally about the core; brown granular excrement occupying the cavity and often protruding from the "blossom" or the side of the fruit. CODLING MOTH, No. 10.

(2) Fruit exhibiting minute, mostly circular, scales upon the surface which, if light colored, is usually reddish purple tinged about the scales. (See above, b. (1), c. (1), d. (1)).
SAN JOSE SCALE, No. 31.

(3) Young apples and pears gnawed by a light green fleshy worm.
ASH GRAY PINION, No. 11.

II. Insects affecting ornamental and shade trees.

a. Affecting the trunk and branches.

(1) Discolored spots on the bark wet from exuding sap, the bark often cracked or broken away disclosing granular excrement and perforated wood. LOCUST TREE CARPENTER MOTH, No. 9.

(2) Bark breaking away exposing furrowed, cracked, and perforated wood, and sawdust-like excrement. (See b. (2) above.)
FLAT-HEADED BORER, No. 1.

(3) Reddish brown flattened or hemispherical protuberances ¼ inch or less in diameter on the branches.
(Infesting various trees and shrubs.) LECANIUM BARK LICE, No. 34.

(4) Elm trees exhibiting whitish patches of old insects on the lower surface of the branches; clusters of minute grayish insects in protected spots on the bark in winter and spring.
IMPORTED ELM BARK LOUSE, No. 36.

(5) Small mussel-shaped dark brown scales on the bark of branches and twigs.
(A serious enemy of apple in the east and middle west.) OYSTER-SHELL BARK LOUSE, No. 33.

(6) Box-elder and cottonwood limbs dying, the bark dark spotted or having a scurfy covering of circular scale insects.
(Other trees often infested.) ENGLISH WALNUT SCALE, No. 32.

(7) Box-elder twigs exhibiting white cottony masses on the sides of the branches and on the axils of the twigs.
(Infesting other trees.) COTTONY MAPLE SCALE, No. 35.

b. Infesting the leaves.

(1) Branches of elms and willows stripped of their leaves by black spiny caterpillars. MOURNING-CLOAK BUTTERFLY, No. 4.

(2) Leaves of poplar and cottonwood eaten by large fleshy, light green worms. POPLAR HAWK MOTH, No. 8.

(3) Minute grayish insects clustered along the veins of elm leaves. (See II, a. (4) above).
IMPORTED ELM BARK LOUSE, No. 36.

(4) Leaf stems of cottonwood bearing a hollow swelling containing insects. POPLAR LEAF-GALL LOUSE, No. 28.

(5) Soft-bodied insects clustered on the leaves, often on the twigs.
Some form of PLANT LICE, No. 19,
On cottonwood, see COTTONWOOD LEAF LOUSE, No. 27.

(6) American elm exhibiting clusters of crumpled leaves enclosing lice.
ELM LEAF LOUSE, No. 26.

III. Insects affecting ornamental shrubs, vines, etc.

(1) Flower buds of roses gnawed into from the side; the petals perforated or falling away on opening. (See I. e. (3) above).
ASH GRAY PINION, No. 11.

(2) Young growth of roses often covered by brownish soft-bodied insects.
ROSE PLANT LOUSE, No. 24.

(3) Leaves of roses becoming light spotted; small white insects on the lower surface, jumping away when disturbed.
ROSE LEAF HOPPER, No. 37.

(4) Rose stalks exhibiting roughened rows of perforations in the bark.
SNOWY TREE CRICKET, No 18.

(5) Leaves of the hop eaten and skeletonized by spiny worms.
HOP-VINE BUTTERFLY, No. 6.

(6) Leaves of hollyhock eaten by black spiny worms feeding beneath a web. HOLLYHOCK BUTTERFLY, No. 5.

IV. Insects affecting garden shrubs.

(1) Raspberry and blackberry stalks exhibiting roughened rows of perforations in the bark. (See III, (4) above.)
SNOWY TREE CRICKET, No. 18.

(2) Currant and gooseberry stalks bored along the pith, brown excrement present, a whitish worm often present.
CURRANT STEM BORERS, No. 12.

(3) Currant and gooseberry stalks exhibiting an ashy, scurfy, surface; dying; dead leaves retained. (See b. (1), c. (1) and d. (1) of I above). SAN JOSE SCALE, No. 31.

(4) Currant bushes exhibiting crumpled clusters of leaves at the tips of the stems; insects within. CURRANT LEAF LOUSE, NO. 25.

(5) Currant stalks bearing reddish brown protuberances ¼ of an inch or less in diameter. (See II a. (3) above).
LECANIUM BARK LICE, NO. 34.

V. Insects affecting garden vegetables.

a. Affecting the cabbage.

(1) Leaves perforated, often skeletonized.

a. By green velvety worms.
IMPORTED CABBAGE BUTTERFLY, NO. 3.

b. By smooth light green, hump-backed worms.
CABBAGE PLUSIA, NO. 13.

c. By colonies of dark colored worms, or by larger worms brightly colored with black, white and yellow.
(Other plants infested.) ZEBRA CATERPILLAR, NO. 15.

d. By very small light-green worms; a thin membrane covering the smaller gnawed spots.
(Turnips and radishes also infested.) DIAMOND-BACK MOTH, NO. 17.

(2) The leaves exhibiting colonies of green, mealy-skinned lice, chiefly on the lower surface. CABBAGE LOUSE, NO. 22.

(3) Young plants gnawed off at the surface of the ground.
CUTWORMS, NO 16.

b. Affecting other vegetables.

(1) Ears of garden corn burrowed by striped worms.
CORN EAR WORM, NO. 14.

(2) Tomato leaves eaten by a large fleshy worm.
TOMATO WORM, NO. 7.

(3) Tomatoes bored into by striped green or brown worms.
CORN EAR WORM, NO. 14.

LIST OF INJURIOUS INSECTS.

No. 1.

FLAT-HEADED APPLE TREE BORER—*(Chrysobothris femorata)*—*Diagnosis:* Apple and other fruit trees are frequently destroyed by this insect whose presence is shown, in an advanced stage of attack, by the dead and cracked bark of the trunk and limbs. Usually more or less of the bark has fallen away exposing the dead wood and considerable sawdust-like excrement, the wood furrowed and punctured with oval holes. Trees having this appearance have probably been affected for several years. Young trees are apt to assume a sickly appearance. The bark covering spots affected by the insect becomes sunken and discolored, dies and cracks. Weak trees are ordinarily affected worst.

The insect in question is a beetle in the mature stage. It is rarely seen except on warm bright days in early summer, when it is sometimes found basking in the sun on the trunk and limbs of the trees.

The larva which does the mischief is creamy white, ½ to ¾ of an inch long, the portion of the body just back of the head broad and flat, (whence the common name), the remainder of the body slender, rather bead-like, and almost always bent around to one side bringing the two extremities near together. The larva, which is ordinarily easily found, is practically sufficient to identify the insect.

The eggs are laid in early June in rough places on the bark. On hatching, the young worms eat through the bark, then feed for the greater part of the season upon the young wood just beneath. Old trees thus affected show from a third to a half of the diameter of the infested limbs with the young wood eaten away, often for a distance of several feet along the limb or trunk, as the case may be. The bark is in this way killed and eventually falls away. The exposed part of the wood is furrowed, the furrows frequently filled with the sawdust-like castings of the larva. It dies and usually checks. Oblong holes in the wood, some open and others filled with dust, show that the larvæ penetrated the wood after destroying the young sap-wood. Within the burrows in the wood, the worms change to white pupæ which in spring transform again becoming mature beetles. The beetles are about half an inch long, somewhat flattened, dark green on the back with a bronzy lustre, the bronzy or coppery lustre particularly evident beneath. The sexes vary somewhat in size.

Strong and vigorous trees are ordinarily not infested by this insect owing, probably, to their large quantity of sap. On the other hand, weak trees of any age, and young trees recently transplanted are very commonly affected in all parts of the country. Furthermore, it will be noticed that the south and southwest sides of the trees are most commonly attacked. Owing to the small diameter of young trees, these are frequently completely girdled before the larvæ enter the wood.

The complete control of this insect is attended by considerably more difficulty than is experienced in the cases of many others. It is, however, none the less important.

In the case of young trees, weakened by transplanting, careful examination should be made to determine the presence of the larvæ. Digging them out with a knife blade is the first and most important step. In autumn the appearance of the bark, as stated above, may reveal the presence of young borers which will demand like treatment. Soap has proved to be a good repellent of the beetles; hence, washing the trunk and lower limbs of the trees with strong soap water, beginning about the middle of May, and repeating as often as necessary during summer, will be found valuable in preventing the laying of eggs. The addition to the wash of sufficient crude carbolic acid to give it a distinct odor, will doubtless make the wash more effectual. Fish-oil and whale-oil soaps are valuable kinds to use in this work. Other materials to be used in spraying are advised, but the soap wash is given here owing to its availability. The common practice of whitewashing the trees is not wholly without purpose against this insect. The work should be done thoroughly and during the same period as given for the application of the soap. The benefit arising from the use of whitewash lies in the inability of the young larvæ to penetrate the coating of whitewash in trying to enter the bark. Keeping the tree free from old scales of bark is of advantage.

While this insect is designated as an apple-tree borer, it is nearly as frequently found infesting other fruit trees, pear, peach, plum, etc., also the stalks of the currant. Perhaps less frequently, but not uncommonly, it injures various shade trees.

No. 2.

PEAR AND CHERRY SLUG—(*Selandria cerasi*)—*Diagnosis:* Each year in June and July, pear and cherry trees become infested by small, shining, slimy, olive green worms which feed on the upper surface of the leaves causing them to turn brown in spots, or eventually, wholly so. If badly infested, the tree assumes a scorched appearance and sometimes the leaves fall away entirely, a new foliage taking their place.

This very evident injury to these trees is caused by an insect which, in the mature stage, is a small, black, four-winged fly less than a quarter of an inch in length. This stage of the insect is rarely seen, though the injury producing larvæ are well known to orchardists in western Nevada.

Bulletin No. 10 of this Station contains an account of this insect which is not repeated here.

The insect is not a difficult one to control if the essential features of its life-history and habits are borne in mind in the application of remedies.

There are two broods of insects developed each summer. In early June mature flies emerge from their cocoons in the ground where they have remained over the preceding winter. Eggs are deposited in the substance of the leaves just beneath the upper surface. In a couple of weeks the young larvæ appear, breaking through the upper skin of the leaf on hatching. They at once begin to gnaw away the upper surface, excepting the veins. For nearly three weeks this proceeds, during which time the larvæ attain their growth, and near the close of which they cast the slimy skin. They soon after leave the foliage and go into the ground. There they form brown oblong cocoons a few inches beneath the surface. A couple of weeks later they emerge as perfect insects and proceed to deposit eggs for a second brood. The larvæ of the second brood remain on the leaves during the greater part of August when they, too, go into the ground to remain until the following June.

Thus, from the habits of this insect, it is seen that the spraying of remedies should be done at various times in June and again in August, when the larvæ are upon the foliage. On each occasion, this should be begun early enough to prevent the injury to the tree. Again, since the insects spend a part of their existence in the ground but a short distance beneath the surface, it is evident that active cultivation of the soil beneath and about the trees soon after the first brood of larvæ has disappeared from the leaves, and again in autumn, would destroy many insects, which, in the case of an isolated orchard, would be of material benefit.

The following is taken from the bulletin cited above:

"The experiments with tobacco decoction, white hellebore and buhach, performed at the Experiment Station, prove the value of these as remedies for the pear slug. A double handful of refuse tobacco was boiled and the decoction diluted to form eight or ten gallons. A table-spoonful of white hellebore to five gallons of water, and the same amount of buhach in the same amount of water, were separately sprayed upon different trees, resulting in each case in the death of nearly all the slugs. A second application took them all. These being vegetable compounds, no injury to the foliage is at all likely to result, which is not always true in the use of inorganic compounds."

No. 3.

IMPORTED CABBAGE BUTTERFLY—(*Pieris rapæ*)—*Diagnosis:* During summer, the leaves of cabbages become perforated and large holes often extending to the veins are produced by green velvety-skinned worms. Various sizes of the worms are to be found, the largest somewhat over an inch in length. They may occur on all the leaves, particularly on the intermediate ones, and those immediately about the head. These are often completely skeletonized, the denuded veins standing upright in conspicuous evidence of the presence of this insect.

Gray, speckled chrysalids about three-fourths of an inch long, suspended from the pointed extremity and by a silken loop, are often found attached to the leaves or other objects near by.

The presence of white butterflies, seemingly confined to the cabbage area, is almost sure indication of the presence of these worms in destructive number.

This is an imported insect which has became naturalized in nearly all parts of the United States. It was first seen about Reno in 1895, since which time it has become very common. For the past two years it has been very abundant and has proved very injurious to cabbages. The writer has found it on mignonette completely stripping the plants of leaves. It seems to be two brooded in this locality, the first butterflies to be seen certainly not later than early June.

The insect's eggs are laid upon the leaves of the cabbage. The young larvæ feed until maturity as indicated in the diagnosis. Some of them form the chrysalis on the under surface of the leaves upon which they have fed, while others leave the plants, seeking some over-hanging shelter near at hand. The period of appearance of the second brood of butterflies is irregular, which results in both the butterflies and the worms being found until the close of the growing season.

These worms cannot be mistaken for any others now known to infest garden plants in Nevada. Their light to dark green color, velvety surface, a narrow yellowish line along the back, another line and a row of yellowish dots on each side, should serve to make their identification practically certain. The wings of the butterflies are white above, somewhat yellowish beneath, the front wings being black at the tip, a black spot on the front edge of each hind wing and one (in the male) or two (in the female) additional black spots on each front wing. The wings' expanse varies from 1½ to 2 inches.

The above description will serve in distinguishing this insect from the common native white butterfly, *(Pieris occidentalis)*, whose larvæ sometimes feed upon cabbage, though more commonly upon various weeds belonging to the same family as the cabbage, notably, the common hedge mustard, *(Sisymbrium canescens.)* The larva of the latter insect is yellowish with black spots; the butterfly having numerous black spots and lines on a white background.

Spraying the plants with buhach or white hellebore destroys these insects without danger of injury either to the plants, or their consumers. The writer has found the use of these powders, combined with kerosene emulsion at the strength of 1-16 oz. of powder to each gallon of the emulsion as used, to be destructive to these larvæ, the emulsion killing the equally destructive cabbage lice, though not fatal to the butterfly larvæ when used without the buhach or white hellebore.

Destroying the useless outer leaves of the plants will also destroy many of the chrysalids of this insect.

No. 4.

MOURNING-CLOAK BUTTERFLY—*(Euvanessa antiopa)*—*Diagnosis:* Branches of the elms and willows are often defoliated by colonies of purplish black caterpillars. They remain in a colony migrating in a body from a defoliated branch to a new one.

These caterpillers are the larvae of a very common butterfly which may be seen at almost any time from earliest spring until very late autumn or even on warm days in winter, as, unlike most of the butterflies, this one passes the winter in the butterfly stage. The wings are deep purplish brown bordered by a band of yellow sprinkled with brown, a band of black just within this containing a row of blue spots, and a pair of yellowish spots occurring on the front edge of each front wing. The wings expand about two and a half inches. The full grown caterpillars are two inches or more long, purplish black, sprinkled with white, a row of red spots along the back, the body covered with sharp spines.

There are, probably, two distinct broods of this insect in Nevada, the first brood of larvæ appearing about June, the second in August or September.

The butterflies are very common in spring and again in early autumn. Those of early spring often have torn wings showing that they have passed the winter in the butterfly stage.

It is said that these caterpillars feed upon a variety of trees and shrubs, but here they have been noted only on the elm and willows, particularly the latter, which line rivers, ditches and mountain streams everywhere in this region.

Owing to the fact that the caterpillars feed in colonies, cutting away and destroying infested branches is the most practicable remedy to employ.

No. 5.

HOLLYHOCK BUTTERFLY—*(Vanessa caryæ)*—*Diagnosis:* Each year about the time the stalks of the hollyhock are full grown, the leaves begin to present gnawed patches on the upper surface, which is more or less covered by a web by which the edges of the leaves are drawn together upward; or, in larger leaves, the edges are drawn over against the upper surface. One or more spiny caterpillars are, ordinarily, under each web.

The hollyhock is annually injured by the larvæ of this butterfly, often to a serious extent, as has been observed at the University, where certain plants growing in a warm, bright and protected spot have been practically defoliated on each of several years past. The effect on the flowers has been very noticeable, as they have scarcely attained half the usual size, and have presented a sickly appearance otherwise. When the full effect of the injury to the plants appeared, the leaves presented the appearance of having been scorched, as by fire.

The parent of this insect is a very common, reddish, spotted butterfly to be seen from spring until late autumn. It seems to have the habit of alighting on the ground, soon flitting away a few feet or yards and alighting again, thus being one of the few butterflies seemingly always in one's path on warm, bright days. This habit is accounted for by the fact that the common mallow or "cheeses" is abundant everywhere about the streets and dwellings. This plant is closely related to the hollyhock and its leaves are commonly fed upon by the larvæ of this butterfly, which is actively depositing eggs upon the leaves, while apparently aimlessly flitting about on the ground.

In like manner, the eggs are laid on the hollyhock leaves at different times in spring and early summer, consequently larvæ of different sizes are to be found at the same time feeding upon this plant.

There appears to be two broods of this insect annually, there being a period in summer of comparative cessation of the attack of the worms. Spraying the plants with Paris green before the eggs have hatched, should prevent the injuries from these caterpillars.

Another butterfly, *Vanessa cardui*, closely related to the one just described, which feeds on the hollyhock in other parts of the country, is common in this region, but thus far has not been found feeding on the hollyhock here.

No. 6.

HOP-VINE BUTTERFLY—*(Grapta satyrus)—Diagnosis:* The leaves of the hop-vine are very commonly eaten away and skeletonized, when only the principal veins remain, by a spine-covered white-backed caterpillar, which spends the day in hiding on the lower surface of the leaves.

There are at least two broods of these caterpillars, and they may be found from midsummer or earlier, until late autumn. They are an inch or more long at maturity, when they form a grayish chrysalis having some silvery spots on one side. The chrysalids are suspended from some overhanging object in the immediate vicinity of the plants upon which they have fed. From the chrysalis, there develops a beautiful reddish, brown spotted butterfly, the wings of which expand nearly two inches. Another very similar species, *Grapta zephyrus*, which commonly feeds on wild plants, is occasionly found on the hop.

The use of Paris green spray, where hand picking of the larvæ is not feasible, would probably hold this insect in check.

No. 7.

TOMATO WORM—*(Phlegethontius celeus)*—*Diagnosis:* The leaves of the tomato, potato and also tobacco are injured by a large fleshy, usually green, worm. The leaves are eaten away, only the larger veins remaining.

This is a very common insect familiar in the larval stage, at least, to most people. The larva is three or four inches long at maturity, green or sometimes brown in color, having several diagonal lighter stripes on each side and a horn-like projection near the hinder extremity. In the latter part of summer the worms burrow into the ground and change to reddish brown chrysalids about two inches long. The tongue of the future moth is folded back against the body of the chrysalis "jug-handle" fashion. These chrysalids are often brought to light by the plow or cultivator in the early preparation of ground previously used in growing the plants upon which this insect feeds. There eventually developes from the chrysalis a large moth having a wing expanse of four or five inches. The wings are ashy gray, beautifully variegated and cross marked with bands of black. The body is black, white and yellow spotted. The moths fly at night sipping the nectar of flowers. They are attracted and many of them destroyed by electric lights.

Hand-picking the larvæ from the plants is the most practical means of disposing of them

No. 8.

POPLAR HAWK MOTH—*(Marumba modesta)*—*Diagnosis:* Large fleshy worms are frequently found eating the leaves of the poplar and cottonwood. They may be found crawling on the trunk of the tree or the ground in the vicinity of these trees. One's attention is frequently directed to them by their conspicuous excrement lying on the ground beneath the branches upon which they are feeding.

When full grown, these larvæ resemble, somewhat, the large worms which feed upon the tomato. They are then about the size of one's finger and measure about four inches in length. They are light green in color, simulating the color of the leaves upon which they feed. Upon each side are several light diagonal stripes, and near the hinder extremity is a horn-like projection. The head, a saddle-like area just back of the head and the hinder extremity of the body, have a rough granular surface. When mature, in the latter part of summer or early autumn, they go into the ground and transform into robust, reddish brown chrysalids, in which form they remain until spring, when the mature insect emerges as one of our largest moths, having a wing expanse of about five inches. The color of the moth is most modest, the front wings, usually, a faded light brown with more or less distinct wavy cross markings. The hind wings are characteristically reddish purple in the center with dark spots near the hinder angle. The moths are very commonly attracted by electric lights, their burned bodies often being found beneath the lamps in the morning.

This insect has not been found sufficiently common about Reno to be materially injurious to the poplars and cottonwoods. It was, however, reported upon one occasion, from Hawthorne, as having seriously defoliated the cottonwood trees there.

Should it become a serious insect in any locality, the thorough cultivation of the ground about the trees in late autumn would very materially reduce the number of insects which would otherwise appear the following year. The use of the arsenical poisons, Paris green and London purple, would probably prove effective in protecting individual trees.

No. 9.

LOCUST TREE CARPENTER MOTH—*(Prionoxystus robiniæ)* —*Diagnosis:* Various shade trees, as the locust, elm and poplar, often exhibit evidence of the presence of a large boring insect working in the trunk or larger limbs. This may appear as discolored moist spots on the bark; or, in addition, the bark may be broken away, exposing a mass of wet or dry granular excrement and fine chips, and frequently large holes leading to the interior of the tree.

Such is the common external evidence of the presence of the locust tree carpenter moth. On cutting open the trunk or limbs at the point of infestation, burrows the size of the finger, or smaller, are found to penetrate the wood, often to the centre. One or more fleshy larvæ will also be found. These have a brown head, the body pinkish or yellowish white The size may be variable, some of them being three inches or more long. The insect passes two or three years in this stage while attaining its growth, when it forms a brownish chrysalis near the exit of one of its burrows. At the close of this period the chrysalis wriggles its way to the exit and transforms into the mature moth The two sexes differ considerably in size and general appearance. The female is gray, in general, resulting from a network of lines and spots of dark brown against a whitish background. The wings expand nearly or quite three inches, but lie folded over the back of the insect when at rest. The male is scarcely more than half as large, the hind wings tawny, bordered with dark brown.

The moths fly in summer, many of them being attracted to electric and other lights. The eggs are laid in the crevices of the bark.

This is a difficult insect to control. By keeping the trunk and branches thoroughly washed with strong soap, with the possible addition of some crude carbolic acid, it is probable that many of the moths would be repelled from the trees during the egg-laying season. Choice shade trees should be frequently examined for evidence of the presence of the young larvæ.

No. 10.

CODLING MOTH—*(Carpocapsa pomonella)*—*Diagnosis*l - The larval stage of this insect is that which gives us the "wormy" apples so well known by every one. Other orchard fruits are sometimes injured by this insect, but it is most widely known as a pest of apples. Its presence in the orchard is recognized by the reddish brown excrement protruding from the blossom end, or from holes in the side of the fruit. In the case of early varieties, many wormy apples will be found on the ground, having fallen prematurely. The removal of old scales of bark after mid-summer will disclose white cocoons half an inch long lying beneath them. These cocoons may also be found in spring in the crevices or corners of boxes or bins where apples have been stored during winter.

On cutting open an infested apple near the period of maturity of the larva, the injury will be seen to have apparently centered about the core and will often show the origination to have been at the blossom. The larva, a half inch or more long, when full grown, is usually pinkish with a brown head. If shaken from the apple, it will often drop by a slender silken thread, a means for leaving the fruit often practiced in the orchard. The cavity caused by the larva is discolored and partly filled with brown excrement; and, if examined after the larva has left, will be found to have a communicating tunnel leading to the surface, usually at one side.

This insect has been treated somewhat at length in Bulletin No. 8 of this Station, and again more briefly in Press Bulletin No. 4, issued in April, 1893. Only the essential features of its life-history having bearing upon the remedies employed thus need to be given here.

The parent insect, a grayish-brown night-flying moth having a wing expanse of about three-fourths of an inch, is rarely seen by those not particularly interested in insects. The first moths of the season come forth in May or early June, from cocoons in which they have passed the preceding winter in an undeveloped state. During the week or two following their appearance, eggs are deposited for the second brood. The belief respecting the egg-laying habits of this insect which has prevailed for many years, seems to be overthrown by observations made by Prof. F. W. Card, in Nebraska in 1897, and reported in Bulletin No. 51 of the Nebraska Experiment Station. These observations go to show that the eggs, with comparatively few exceptions, are laid on the upper surface of the leaves, particularly those near the fruit clusters. Further, that the larvæ frequently feed to some extent upon the leaf tissue before entering the fruit; also, that in endeavoring to secrete themselves while entering the apples, they may enter either at the calyx cup or blossom end, or at some other point on the surface, as where two apples touch. In the majority of cases observed, entrance was made at the calyx.

Upon hatching, the young worm gnaws its way to the interior of the fruit. In from four to six weeks it completes its growth and leaves the fruit seeking some protecting crevice, as beneath scales of bark, in which to form its cocoon. In a couple of weeks a second brood of moths appears from these cocoons. The egg-laying process is now repeated, but differs from the first, in that the eggs are mostly placed on the sides of the fruit, notably where the apples touch each other, or an adjacent twig.

Throughout the intermediate belt across the continent, two broods occur each year. In the north, but one is usual, while in the south three are reported. In Nevada, two broods annually is doubtless the rule.

In any case, the larvæ of the last brood hibernate either within stored fruit or in cocoons, the moths emerging the following season.

Based upon the preceding outline of the life-habits of the codling moth, we have various remedies and means for lessening the number of the insects.

The commonest and most effectual means formerly employed, and one still servicable in the latter part of summer and autumn, is that of banding the trees by placing loosely a band of burlaps about the trunk. Beneath this many cocoons are formed. By removing the band in autumn or winter, and dipping it in boiling water, many future moths are destroyed. Bands of paper may be used instead of burlaps. These are cheaper and may be burned when removed, new ones being placed in their stead. By well stocking the orchard with hogs in early summer, and again in autumn, infested windfalls are profitably disposed of.

Because of the fact that the moths fly at night, trapping them by lights has been attempted—a useless practice, since while many other moths are attracted to the light, the codling moth is not.

The course which has been found most satisfactory, both in reducing the number of insects, and in protecting the fruit the same season as followed, has been the use of Paris green or London purple in water mixture. These are arsenical poisons, and the theory of their use is that the codling moth larva in gnawing through the surface of the fruit, which has been previously poisoned by spraying, receives a fatal quantity of the poison, and is thus prevented from entering the fruit. The idea of danger to man and the higher animals resulting from this course has been proved a falacy. (See Bulletin No. 8 of this Station.) While both these poisons have been employed successfully, Paris green is given the preference since its strength is more constant and its purity is more easily determined. They are employed in simple mechanical mixture with water, at the strength of one pound of Paris green to 200 gallons of water, or a pound of London purple to 150 gallons, at the usual strength of London purple. Continued agitation of the mixture while being applied is required in order to maintain a uniform strength. The addition of a pound of unslacked lime to the above amount is of benefit in preventing the burning of the foliage.

The first treatment is the most important, and the proper time for its performance is most easily determined. It should be made within a few days, at the most, after the blossoms have fallen. The writer believes that this application should be made as soon as the blossoms are wholly gone from the trees. In some localities, the appearance of the moths may not occur for a week or more after the fall of the blossoms, in which event it might not be necessary to spray so early; but, until this interim is proved to be constant for all parts of the country, which the writer does not think will result, it will probably be found better that the first application be made as suggested, as soon as the tree is wholly out of blossom. It is not advisable to spray while the trees are in blossom for two reasons: namely, the very possible danger of killing honey bees; and, of destroying the essential organs of the flowers and thus preventing the formation of the fruit. Like the first, the time for the second application should be based upon the condition of the young fruit at the time it is made. Prof. Card, in Bulletin No. 51 of the Nebraska Station, has pointed out the importance of spraying while the calyx cup, or "basin," of the young fruit is still open. Thus, if a second spraying is to closely follow the first, it would be most advantageously done within two weeks after the fall of the blossoms, say a week and a half following the first application. The very important question of further applications, probably, cannot be answered by the designation of definite dates for spraying owing to the great irregularity of the breeding habits of the insect after mid-summer. However, three or four applications following the two above mentioned, made at the somewhat arbitrarily taken period of fifteen days apart, may prove of much value. Care will have to be taken, however, to prevent the injury to both foliage and fruit that is apt to result from such frequent treatment.

The following account of spraying done by this department was presented as Press Bulletin No. 10, issued in October, 1893:

"In June of the present year [1893] the Entomological department of the Experiment Station undertook experiments to determine the efficiency of spraying with Paris green in preventing the destructiveness of the codling moth, the parent of the worm so injurious to the apple crop of Nevada. Efforts in this direction have been made in previous years, but they have been confined to one, or at most, a few trees at a place. In some of these cases the result was very satisfactory, while in others it was but partially so. This variation in results has, without doubt, been chargeable to a lack of care in the application of the poison. The results in those cases that were satisfactory were quite apt not to be considered as indicative of results in field practice, owing to the small number of trees treated in each case. Thus it was to determine the cause of former failures, and to make the conditions of the experiment conform as nearly as possible to those of actual field practice, that the following work was performed:

"A block of forty-eight trees in the orchard of Mr. A. B. Williams, on Sixth street, Reno, was selected for treatment, the remaining portion of the orchard being left untreated to serve as a check upon the work. To improve the conditions of the experiment in this respect, the two adjacent rows of the two portions of the orchard are of the same variety (the Ben Davis), and each was well laden with fruit. The poison used was Paris green in water mixture at the strength of one pound to 225 gallons of water. During the process of application, much care was taken that as complete mixture as possible and thus a uniform strength should be maintained. While care in this respect permits the fruit to receive more nearly uniform treatment, it is most important in preventing the injury to foliage due to too great strength of poison, which tends to settle to the bottom of the vessel from which it is drawn.

"The first application was made June 1st and 2d. The row of Ben Davis trees was given a second treatment on June 24th. The remaining trees thus received but a single application, that of June 1st and 2d. At the time of the first treatment the blossoms were falling. On the second application the average size of the fruit was that of a walnut.

"An examination of the orchard in the second week in September, when a fairly careful observation of the trees was made in passing from one to another, resulted in there being found less than a dozen examples of wormy fruit on the trees which had received the preventive treatment. The row twice sprayed, apparently, had been much benefited by the second application.

"An examination of the portion of the orchard not sprayed showed a large percentage of the fruit to be wormy. This was particularly noticeable on the row of Ben Davis trees *adjoining that of the same variety which was sprayed.* The fallen fruit naturally showed a greater percentage injured, but the relative proportion of such in the two parts of the orchard seemed not materially different from that in the fruit still on the trees.

"It is to be noted that the examination was not a close one. Greater care in this respect would have revealed more injured fruit from the trees experimented upon. However, the effect of the work was noted very much as it would be ordinarily in picking the fruit.

"The result of similar spraying by Mr. Wm. E. Gould in his orchard east of town is very satisfactory. Here, too, there appears a noticeable difference in favor of trees sprayed twice, over those receiving a single application.

"It is believed that one of the most important factors in the work in each of these cases was the use of the "extension" pole, by which the spray nozzle was brought in close proximity to the young fruit, thus permitting it to become thoroughly wet

"While exact information on the above results is not available, sufficient can be determined to make them very satisfactory, and the scale upon which the work was undertaken gives a fair indication of what may be hoped for in this method."

No. 11.

ASH GRAY PINION—*(Lithophane antennata)* — *Diagnosis:* Young apples, also the buds of roses, are sometimes bored into by light green, white-striped and spotted worms. The hole penetrating the fruit or buds is about one-fourth of an inch in diameter. The fruit is often killed; and, in the case of injury to rose buds, the petals are either conspicuously perforated, or fall as soon as the bud opens.

Bulletin No. 9, of this Station, contains an account of this insect injuring roses in 1890, in which year it was exceptionally injurious to roses about Reno. Since that time the larvæ have been found, a few each year, on the apple and on rose bushes. It has not, however, seemed to do material injury.

The larvæ are to be found, usually, hidden among the leaves, near the point of feeding. The following description of the larvæ is taken from the above cited bulletin:

"The full grown larva is about one and three-eighths inches long, cylindrical, free from hairs, and presents a light-green colored background. Many creamy-white spots are sprinkled over the body, which bears a narrow but distinct creamy-white dorsal line, and a somewhat wider one along each side. These lateral stripes are widest at the posterior end of the body. Midway between the lateral and dorsal stripes is a distinct line of white spots and below each lateral stripe is a somewhat broken line of the same. The anterior dorsal margin of the first segment back of the head bears a white collar."

The moth developed from the larva has a wing expanse of about one and one-half inches. The front wings are ashy gray, the hind wings brown. It flies at night and is rarely seen.

It is not probable that this insect will cause sufficient damage to call for especial consideration other than the shaking of the bushes and forcibly spraying them with water.

No. 12.

CURRANT STEM BORERS—*(Sesia tipuliformis, Chrysobothris femorata)*—*Diagnosis:* The stalks of the several kinds of currants, also those of the gooseberry, are frequently found bored longitudinally along the pith for the distance of several inches. The cavity is ordinarily filled with fine sawdust-like excrement and chips. This material is commonly black, or dark colored at least, and wet from the presence of sap. In autumn or spring, a light colored worm is usually to be found at one extremity of the cavity. Occasional holes the size of the tip of a pencil are to be found penetrating the bark and wood to the cavity. The stalks appear unhealthy, and are often broken down by the force of the wind.

Both of these insects have been found infesting the currant in Reno. Though widely different in character, the mode of injury to the stalks produced by these insects is essentially the same.

The first mentioned, *Sesia tipulifomis*, is a small and beautiful "clear-winged" moth in the mature stage. Owing to its foreign origin, and its preference for the currant and gooseberry, it is known as the Imported Currant Borer. It is rarely seen except by the entomologically inclined, who may see it on bright June days flitting about the currant bushes. The eggs are laid upon the stems in June. The young larvæ produced from these eat their way into the stem, a single one in a place. On reaching the pith, they burrow through it lengthwise of the stem, often for the distance of several inches. In this way they spend nearly a year attaining their growth. In autumn or spring, these larvæ are yellowish tinged, the head and front legs brown. In early June, they emerge from a light brown chrysalis case which often projects from the hole in the stem.

This insect is very common in Reno, as it also is throughout most of the United States. It has been said that the insect destroys no more stalks than is good for the bushes. However, the gardener might prefer to do his own pruning.

The application of washes is not adapted to lessen the work of this insect. On learning to recognize the infested stalks, the gardener can trim these out, cutting below the point of infestation. If the work is done in late spring, the infested stalks should be distinguished easily. They should be burned.

The other insect infesting the currant stems in a similar manner in Nevada is the well known flat-headed apple tree borer, discussed more fully under this title (No. 1). As a currant enemy, this insect is far less common than the preceding. The writer has found it in currant stems in a few instances only.

The presence of this insect may ordinarily be distinguished from that of the imported currant borer, by the fact that the infested stalk is usually burrowed beneath the bark which may crack and fall away. The broad, flattened portion of the body just back of the head serves to distinguish this larva from the other.

Cutting away and burning the infested stems in spring would be generally beneficial to the plants. This would not materially reduce the likelihood of future infestation, because of the greater prevalence of this insect upon various trees. A thorough coating of strong soap given the bushes in spring would probably be an effective preventive of injury to these plants.

No. 13.

CABBAGE PLUSIA—*(Plusia brassicæ)*—The leaves of the cabbage are injured in a manner very similar to that caused by the imported butterfly, by the larva of a night-flying moth, the cabbage plusia. *Diagnosis:* Irregular holes in the leaves, and others penetrating the head, are produced by a pale green larva having faint longitudinal stripes and the somewhat peculiar habit of looping up the body when walking. The larva is an inch or more long at maturity, when it seeks some sheltered spot, as between two leaves or on the under side of the broad leaves near the ground, where it spins a thin, frail cocoon nearly three-fourths of an inch long. From the pupa formed within the cocoon, there develops a moth whose wings expand about 1½ inches. The front pair are grayish brown with more or less distinct markings and an irregular silvery spot near the centre, the hind wings brownish.

This insect is to be found on cabbage plants about Reno each year, but has not, as yet, produced serious injury. Many of the pupæ are destroyed by a blue four-winged fly.

The remedies employed against the imported cabbage butterfly will act upon these larvæ, thus destroying them without their being given special attention.

No. 14.

CORN EAR WORM—*(Heliothis armiger)*—*Diagnosis:* Sweet corn raised in western Nevada is very generally injured by a greenish or brownish striped worm which gnaws the kernels, chiefly about the tip of the ear. The injured portion of the ear is discolored, contains considerable brown, wet excrement, and is frequently mouldy. One or several worms may occur in a single ear. In the latter case, they ordinarily vary in size.

Every consumer of sweet corn in this region is somewhat familiar with this insect in the larval stage. The parent insect is a moth, olive-green or light brown in color. Her eggs are laid at the tip of the growing ear, the young larvæ eating their way in to the kernels. When full grown, each larva leaves the ear and passes into the ground where it forms a pupa a short distance beneath the surface. It is probable that two broods repeat this operation annually in western Nevada. The pupæ of the second brood remain in the ground during winter.

This is a difficult insect to combat owing to the character of its injury. Many moths can be destroyed by sweetened poisons placed in the garden. Preventing the maturity of the worms infesting the earliest corn, will greatly reduce the extent of the later injury. Late plowing, followed by harrowing, of ground upon which corn has been grown will destroy many pupæ.

In certain parts of the country, tomatoes have been seriously injured. Only occasional instances of this has been noted here. This is the very injurious Boll Worm of the cotton states.

No. 15.

ZEBRA CATERPILLAR—*(Mamestra picta)*—*Diagnosis:* Among other more common larvæ feeding upon the leaves of the cabbage, may occasionally be found very pretty caterpillars having bright markings in black, white and yellow. They are black along the back, with stripes of yellow on the sides, separated by a band of black having numerous irregular cross lines of white. The head and legs are reddish. When full grown, these larvæ are nearly two inches long.

The parent moth has beautiful purplish brown front wings, the hinder wings being nearly white.

The young larvæ, which are at first nearly black, and later pale green, feed in clusters on the leaves; so, if the plants are watched and such clusters of insects found, their removal will greatly lessen future injury by this insect. The remedies employed against the imported cabbage butterfly will also destroy this insect.

No. 16.

CUT-WORMS—(Various species) — *Diagnosis:* Various transplanted plants and hill growing crops are injured by cut-worms which gnaw off the plants. Wilted, fallen plants indicate the presence of these insects.

Most people are somewhat familiar with the cut-worms which are the larvæ of a large group of night-flying moths.

Only a few statements respecting those of their habits upon which remedies are based are given here. Like the moths which they produce, the cut-worms which injure garden and field crops are nocturnal in their habits, remaining hidden, often under ground, during the day, coming to or upon the surface at night to feed. Young vegetation, either fresh or wilted, is suited to their taste. Thus it is that so many young plants are destroyed by being cut off at, or just beneath, the surface of the ground. On digging about the base of a plant that has been very recently cut off, one or more of the cut-worms usually may be found.

The placing of poisoned bait at intervals upon infested ground has proved one of the most effective methods of destroying the cut worms. Any easily obtained succulent vegetation is sprayed with strong Paris green or London purple water and then placed in small bunches on the infested ground. On coming forth at night, the worms are attracted to this seemingly well prepared food, with the desired result that great numbers of them are fatally poisoned. Alfalfa would serve as a good bait material. It should be sprayed while standing, then mowed and distributed a handful in a place, in the vicinity of the infested plants, the bunches being placed a few feet or yards apart.

No. 17.

DIAMOND-BACK MOTH—*(Plutella cruciferarum)*—*Diagnosis:* Cabbage leaves are frequently perforated or show spots on the surface where the tissue has been eaten away, leaving only the thin, translucent, parchment-like skin of one surface of the leaf. Further examination of the leaves is likely to reveal the presence of some small, light-green worms about a third of an inch long, if full grown, and tapering somewhat toward each end, the presence of the hind pair of legs giving that extremity a somewhat forked appearance. If disturbed, the larvæ wriggle actively and drop, hanging suspended by a silken thread. Upon the surface of the leaves may be found the little cocoons of this moth, each about a third of an inch long and consisting of a frail net of white fibres encircling the pupa.

This little insect is found in many parts of the United States and in many foreign countries. In England it has utterly ruined turnip crops. In some parts of this country it has been reported as very injurious. It has not thus far become sufficiently injurious in Nevada to attract popular attention, yet it seems to be generally present in the cabbage fields.

The moths developed from these small larvæ are about one-third of an inch long exclusive of the feelers, which, when the moth is at rest, are held together and project out in front of the insect's head. The wings are slender, grayish, usually with a white stripe, a part of which belongs to each wing, along the back.

The various transformations are passed very quickly which results in a succession of broods each season.

Since this insect is not, as yet, especially injurious it probably will not receive particular attention from gardeners. The application of the remedies for other more serious cabbage insects, whose periods of activity are the same as that of this insect, will doubtless keep this one within the limit of injurious numbers.

No. 18.

Snowy Tree-Cricket—*(Œcanthus niveus)—Diagnosis:* The stalks of raspberry, blackberry, and the rose, often present narrow longitudinal roughened stripes on the surface of the bark. These roughened stripes are commonly discolored, and frequently show a row of punctures or a split in the bark or wood. They may be straight or curved, and vary from half an inch to two or three inches in length. Shaving off a scarred strip, cutting into the wood slightly, discloses a row of perforations each the size of a pin. Splitting the stem through the perforations, shows them to be slightly curved and to extend to, or into the pith. If the punctures have been recently made, each will contain a yellowish white egg; otherwise only the empty shells will be found.

The insect which causes this injury is popularly called a tree-cricket. It spends the latter part of summer and autumn among shrubs and trees, the males being responsible for much of the chirping heard on warm nights. Each sex is somewhat less than an inch long, with longer thread-like feelers. Both are greenish white. The wings of the male lie flat on the back, those of the female being folded about the body, which is tipped by the slender piercing organ with which the egg punctures in the twigs are made.

The eggs hatch in spring, the young insects feeding during summer upon plant lice found upon, or in the vicinity of, the plants in which they passed the egg stage. In the latter part of summer they reach maturity and in autumn eggs are deposited for the insects of the following year. Thus the insects are both beneficial and injurious.

Cutting out and burning infested branches in late autumn, winter or spring is about the only effectual remedy.

No. 19.

PLANT LICE—*(Aphis spp.)*—The plant lice are the commonest of insects, innumerable species living upon plants grown both indoors, and out. *Diagnosis:* They are soft bodied insects, the commonest greenish in color, an eighth of an inch or less in length, the legs long and slender as are also the feelers. A pair of commonly slender horn-like tubes project from the back at the hinder extremity of the body from which drops of transparent sweetish liquid exude, frequently in considerable quantity.

Their feeding and injury producing habits are accomplished by sucking the sap of the plant through a slender beak with which they pierce the skin of the leaf or stem they infest. They are mostly wingless, but some of each kind develop wings which aid in their dissemination. Eggs are produced in late autumn, but some mature individuals hibernate during the winter. They are easily killed but, seemingly, do not readily "stay killed", for, owing to their wonderful powers of reproduction, they are apt soon to appear again as numerous as ever. They have numerous enemies in predaceous insects some of which aid greatly inreducing their numbers. Prominent among these insects, are the lady-bird beetles or "lady-bugs." Ants so frequently seen among them are there to obtain the sweet "honey dew" which exudes from their bodies.

Bulletin No. 11 of this Station treats briefly of these insects and some of their natural enemies in connection with those that infest the apple.

Several recognized groups, and even more genera, of the plant lice occur upon valued plants in our region. To attempt to designate these by their technical characters would be folly in an article of this kind, but the habits of some of them, briefly stated, cannot fail to make their recognition possible.

No. 20.

APPLE LEAF LOUSE—*(Aphis mali)*—*Diagnosis:* The leaves of the apple, particularly those at the ends of the branches of young trees, are frequently found to curl backward, becoming dwarfed and shriveled. Great numbers of green plant lice will be found on the under surface extending frequently down the leaf stalks to, and upon, the twig. The twigs become stunted and often deformed, bending abruptly sideways. During the preceding winter the terminal twigs of these trees were probably well stocked with small shining black eggs clustered about the buds and scattered over the bark. These were the eggs of the lice which swarmed upon the leaves as soon as they began to form.

Here, the injury caused by these lice seems to be confined principally to young trees, where the worst results follow the injury to the opening leaf and flower buds. The great number of insects in the first broods often permits the young leaves and stems to be almost wholly covered by them. At this time most effective work could be done by spraying the tree with kerosene emulsion, strong soap suds, or tobacco decoction. Later, the more dense foliage and the curled condition of the infested leaves protects the lice to such an extent that many of them would not be reached by the spray.

These lice are subject to a disease, probably of bacterial nature, which destroys a great many of them in the latter part of summer. The disease causes them to shrivel and assume a dark brown color, their bodies remaining attached to the leaf.

No. 21.

WOOLLY APHIS—*(Schizoneura lanigera)* — *Diagnosis:* (1.) The most conspicuous, and usually most evident, character by which this disease may be recognized in Nevada, is the presence of white cottony or woolly masses upon the trunk, especially at points of injury, upon young growth as "sprouts," and upon the branches, particularly in the leaf axils.

(2). The effect of the root-infesting form is to kill the tree without the true cause being clearly evident. The tree's usually slow death becomes evident in the reduced number of leaves which assume a light green or yellowish color. In the advanced stage of the disease, the tree is liable to be blown over by a strong wind, breaking off near the crown. On removal of the earth about the trunk, the roots of the infested tree exhibit a knotted appearance, unnatural excrescences of perhaps dead and decaying tissue taking the place of the natural healthy root. If these roots are still alive, the bluish-white mouldy appearing lice may be found abundant, actively engaged in deforming and destroying the roots.

As Bulletin No. 17 of this Station is devoted to this insect, but a short general account including information on recently demonstrated remedies is here given:

The insect is a specific kind of plant louse which confines its attack to apple trees of all varieties. Immense numbers of the young are developed during the seasons of spring, summer and autumn. From eggs developed in late autumn, each remaining within the dead and shriveled body of a louse resting in a crevice of the bark, young are hatched in early spring. In some climates, such as prevails in Nevada, many of the lice live over the winter, reviving with the coming of the first warm days. During the hibernating period, little if any of the white woolly covering is evident. With the return to activity, however, this covering is developed and the depleted colonies of the preceding season become evident. These persist throughout the season, developing toward its close, winged individuals devoid of cottony covering.

The observations of a number of years confirm the belief that the woolly aphis is a thoroughly well established and seriously destructive enemy to the apple industry of Nevada. Our climate is in every respect most favorable for the existence of the disease. It is so common that in many orchards unaffected trees cannot be found. Often the twigs and limbs are conspicuously scarred. In some instances the limbs exhibit knotty outgrowths the size of the fist and smaller.

The remedies stated on page 7 of Bulletin No. 17 are still in force and generally recommended. Experiments by Prof. J. M. Steadman in Missouri, Bulletin No. 35, Mo. Exp. Sta., 1896, show the efficiency of tobacco dust, employed against the root form of this insect, and of carbon bisulphide in killing insects already established. We cannot do better than to quote from the summary of results given in the bulletin cited:

"Apple seedlings, buds and grafts should be planted in a small trench filled with finely powdered tobacco or tobacco dust and lightly covered with earth. This will keep the woolly aphis away.

"Apple nursery stock should have a liberal supply of tobacco dust applied to the roots every spring in order to kill the woolly aphis and prevent it from establishing itself there. It should be applied by removing some of the earth from around the roots, filling the excavation with tobacco dust, and lightly covering it with earth.

"In planting apple trees, tobacco dust should be freely used among and over all the roots, and close around the trunk, in order to kill and prevent the woolly aphis from establishing itself there.

"Every spring, as soon as settled warm weather appears, each tree should have a liberal supply of tobacco dust applied to its roots by removing the earth from around the trunk for a distance of two feet, and four inches in depth, evenly filling this with tobacco dust and covering it with earth.

"The root form of the woolly aphis may be cheaply and easily killed and kept away from an apple tree by the liberal use of tobacco dust. About 5 or 6 pounds of this substance should be applied as above directed to the roots of every infested tree, and one-half this amount should be applied in a similar manner each succeeding spring, costing approximately two cents per tree per year.

"This insect may also be destroyed by injecting one fluid ounce of carbon bisulphide two feet away from the trunk on two sides of the tree, but the use of this substance is not advised except in extreme cases, since a little carelessness may injure the tree, and it is always necessary to immediately treat the trees with tobacco dust to keep the insect away."

No. 22.

THE CABBAGE LOUSE—*(Aphis brassicæ)*—*Diagnosis:* The insects belonging to this species are very injuries to the cabbage crop in western Nevada. The lice collect on the lower side of the outer leaves of the cabbage, and more or less, upon both sides of the young leaves of the forming head. The outer leaves curl or bend backward, become light colored or yellowish, and finally wilt and die. Those about the head are effected in a similar manner; and if badly infested, as they often are, the head does not form at all.

The lice differ from others commonly seen, in having the body covered by a fine whitish dust or bloom. They may be found in colonies here and there on the surface of the leaf, or so thick as to be closely crowded. They may be found on the plants very soon after setting and thereafter until the crop is harvested, becoming more numerous as the season advances.

The work of controlling this insect commences, properly, with the gathering of the crop in autumn. At this time the land should be thoroughly cleaned of all refuse cabbage plants, such material being burned; especially if the same ground is to be used for cabbages the following season. The object of this is to destroy many insects that would otherwise remain alive over winter, also eggs deposited by the last brood in autumn. Refuse of turnips, radishes, cauliflower, yellow mustard, and all weeds of a similar nature should likewise be destroyed, as the lice will feed upon these if no cabbages are to be had.

Spraying the plants with kerosene emulsion, strong soap suds, or tobacco decoction will destroy the lice; but the treatment has to be repeated as soon as the lice re-appear, as they are almost certain to do, to some extent at least.

Spraying should be done when the first evidence of the presence of the lice appears. The value of the crop and the success of future spraying is very dependent upon the thoroughness with which the first work is done. "Sprinkling" the plants with the best remedy is of little use. A "Cyclone" nozzle attached to a bamboo "extension," the nozzle throwing at right angles to the extension, is probably the best for this work, since both sides of the leaves can easily be reached by the liquid. Later in the season many old and mostly useless leaves lie on the ground securely protecting many of these lice as well as other insects injurious to the cabbage. These leaves may profitably be removed in advance of spraying.

By mixing buhach or white hellebore with the keroscene emulsion, other insects, notably the larvæ of the white butterfly, *Pieris rapæ*, can be destroyed also.

In field experiments, conducted by this department, in which it was desirable to destroy both of these insects, it was found that neither the keroscene emulsion, the buhach, nor white hellebore, when used alone, accomplished the desired end. The combination of either buhach or white hellebore with the emulsion at the strength of 1-16 oz. of the powder to one gallon of the emulsion prepared for use, resulted in the destruction of both insects.

The exposed condition of the cabbage lice leads to the destruction of great numbers of them by predacious and parasitic insects; and the various forms in which these friendly allies appear should not be mistaken by the gardener when seeking the destruction of the injurious kinds.

No. 23.

PLUM LEAF LOUSE—*(Aphis prunifolii)*—In a few instances, plum trees have been noticed to be affected by mealy-bodied plant lice very similar in general appearance to the cabbage lice. In the cases cited, the insects seemed to confine themselves exclusively to the lower surface of the leaves which, in some instances, they completely covered owing to their great number. Active treatment with the proper remedy, using a "Cyclone" nozzle with side discharge permitting the under side of the leaves to be reached easily, should enable one to rid the trees of this insect.

No. 24.

ROSE PLANT LOUSE—*(Aphis sp. ?)*—During summer, rose bushes are frequently seriously infested by plant lice. One species commonly found about Reno is brown in color thus noticeably different from those commonly seen. *Diagnosis:* This species has been found in great numbers literally covering the young growth of stems and leaves at the ends of the branches, giving the plant an unsightly appearance, and doubtless doing it material injury by the withdrawal of much nourishing sap.

Persistent use of a spray of keroscene emulsion, soap water, or tobacco decoction would rid the bushes of these insects.

No. 25.

CURRANT LEAF LOUSE—*(Aphis ribis)*—*Diagnosis:* The leaves of the currant are very generally affected by a plant louse which feeds in colonies on the lower surface of the leaves. The leaves at the end of the stems seem to be affected worst. They curl backward, and, owing to their proximity, clasp about each other more or less, thus forming a conspicuous protective shelter for the insects clustered beneath. Frequently the leaves assume a knotted appearance on the upper surface due to the almost gall-like protuberances caused by the lice.

Suitable spraying or dipping the ends of the stalks should destroy the lice.

No. 26.

ELM LEAF LOUSE—*(Aphis sp. ?)*—A certain plant louse infests the American elm affecting some of the leaves in much the same manner as are those of the currant just described. The dwarfed and curled leaves form close clusters several inches long, usually involving nearly or quite all the leaves of a twig. A great number of insects are protected by the cluster, which, if shaken, gives forth a shower of drops of honey dew.

The American elms about Reno are very commonly affected by this species, the clusters of affected leaves being scattered here and there over the trees. With the fall of the other leaves in autumn, those of the clusters turn brown but remain fast to the otherwise bare limbs during winter.

Cutting off the infested branches in summer, would perhaps be as practicable a method as any to follow where the trees are no more seriously affected than are those thus far observed.

No. 27.

COTTONWOOD LEAF LOUSE—*(Aphis sp. ?)*—One species of plant louse is very common on the leaves of the cottonwoods. They are found on the young twigs also. In the latter part of summer these lice frequently become very numerous. The sweetish liquid which they secrete in considerable quantity is caught by the leaves giving them the appearance of being wet. Insects are attracted and dust caught by this substance giving the tree a very disagreeable appearance.

No. 28.

POPLAR LEAF-GALL LOUSE—*(Pemphigus sp. ?)*—Another plant louse produces the gall-like swellings frequently found on the stems of the leaves of the cottonwood. These galls (see illustration Bull. No. 11, Nevada Exp. Station, p. 3) are enlarged and twisted portions of the leaf stems the size of a marble, lying between the blade and the junction of the leaf with the stem. They are hollow, a partially open slit along one side leading to the interior. On opening the gall, one large parent louse and many small ones are found within, lying among many globules of transparent liquid and the whitish cast skins of the young lice.

No. 29.

WILLOW STEM LOUSE—*(Lachnus sp.-?)*—One of the largest of the plant lice often attracts attention as occurring on the willows, both the common wild shrubs, and the cultivated tree of which there are a number of specimens about Reno. These insects, which have red bodies, are to be found in clusters containing from a few to several hundred individuals; resting on the trunk, branches or twigs of the willows. A blood red liquid results from crushing the bodies of a colony of these insects, a fact frequently the subject of comment on the part of non-entomological observers.

No. 30.

SCALE INSECTS OR BARK LICE, ETC—This group contains many of the most injurious of the insects. Because of the fact that these insects in many instances are protected by a scale-like covering consisting of the dried body wall, moulted skins, or secretions from the body of the insect, the term scale insects has been applied to them. Furthermore they are essentially bark infesting, though they often occur on the leaves and fruit also.

Of the several representatives of the group that occur upon domesticated plants in Nevada, the San Jose Scale is the most destructive.

No. 31.

SAN JOSE SCALE—*(Aspidiotus perniciosus)*—*Diagnosis:* The presence of the San Jose Scale insect is manifest in a number of ways including its appearance upon the plant or fruit, or the effect it produces upon them. As a disease of the orchard, it may be recognized at a distance of a few yards or even rods by the ashy-gray aspect of the lower part, at least, of badly infested limbs, which replaces the normal clear color common in young trees. If these limbs have died within the growing season after the leaves have formed, the conspicuous brown dead leaves persistently remain, even over winter. Closer examination shows the surface of the bark to be somewhat roughened. Rubbing with the nail produces a yellowish oily moisture, resulting from the crushed bodies of the insects. Scraping the bark with a blade shows it deeply reddish purple colored within. The twigs show the scales usually scattered, their form more or less distinctly outlined against the bark. Often the surface about the scale is depressed and dark or purplish colored. The leaves, when the scales are numerous, become lighter colored, often yellowish, the portion immediately about the scales darker; brown dead leaves persisting long upon the branch. Fruit, infested to any extent, either in the orchard or on the market, may be easily recognized. Light skinned apples and pears become reddish purple about the scales giving them a suspicious spotted appearance. The individual scales often appear distinctly outlined against the dark skin of plums. Infested fruit is, furthermore, liable to be dwarfed, deformed, and often cracked, decaying easily.

Bulletin No. 29, 1895, of this Station, contains a preliminary account of this insect in Nevada which it is unnecessary to report here. The two years since the publication of that bulletin, have fully confirmed its closing statement respecting the serious aspect which the disease presents in Nevada. Within this period many new localities of infestation have been located within the Truckee Valley. Its presence in a grave degree at Hawthorne, in Esmeralda county, has been demonstrated by infested material received from an orchard located there. Orchards which two years ago contained but a tree or two showing scales, are now very generally infested. While the writer does not recall having seen entire trees dead evidently from this disease, trees in which from one to several limbs have succumbed to the disease are of frequent occurrence. Badly infested locally grown fruit is to be found in the market.

Aside from the above cited bulletin. two press bulletins have been issued, one on Sept. 30, 1896, the other on Sept. 4, 1897. Altogether, three parties have applied to the department for suggestions as to the care of their orchards, and a possible half dozen people are known to the writer as contemplating doing something to check this destroyer of fruit trees. But greater activity on the part of orchard owners than this, will prevail before any marked improvement in the present condition of the San Jose Scale problem in Nevada becomes manifest.

Respecting practical work performed by the Experiment Station, it may be said that much remains to be confirmed. It is hoped a part of this will be accomplished the present winter.

An account of the first work in this direction by the Station was given in press bulletin No. 20, issued Sept. 30, 1896, from which the following is quoted:

"On May 9, 1896, some very badly infested apple and plum trees were sprayed with a strong wash of whale oil soap (2 pounds of soap to 1 gallon of water). But a single application was made. Especial care was taken, however, to thoroughly wet all parts of the trees, which end seemed to be secured, excepting, possibly, the ultimate branchlets. The work was done later than was desirable as the leaves had already appeared. The leaves were badly crumpled and shriveled by the wash, which condition they have maintained during the season. The younger leaves which had not expanded have presented a most healthy appearance, in sharp contrast to the contorted leaves of early spring.

"Observations upon the insects made within the following fortnight, failed to disclose any living insects where myriads existed before treatment. The real result was expected to appear later in the season when the young of any survivors should make their appearance. Careful examination of these treated trees at the present date shows the scales loosened and falling away, with only an occasional living insect to be found. A few scales are to be found on the leaves from the outer branchlets, which shows that the wash was least effective at these branchlets.

"Notwithstanding the absence of complete success, the result was better than was expected, and gives promise of even better success in experiments to be pursued during the coming winter"

On December 8th, 9th and 10th, 1896, further spraying was done in the same orchard where the work of May 9th was performed. Whale-oil soap at the strength of two pounds to a gallon of water, was used. As before, the soap and water mixture was used while nearly boiling hot in the pail from which it was pumped. Besides spraying several trees not previously treated, two or three of those sprayed in May were again sprayed as thoroughly as possible. The weather remained clear and bright, with freezing at night for a week or more following the spraying. Examination of the sprayed trees a few days after treatment showed the scales loosened the insects beneath brown and shriveled. Examination of all the trees treated, in Sept., 1897, nine months later, when in fruit, showed the real results most clearly. One apple tree, badly infested when sprayed in May '96 and not sprayed in Dec. '96, showed scattered healthy scales on all parts including the leaves. A plum tree thickly coated with the scales in May, sprayed then, and again in December, was seemingly completely freed of the insects. An old pear tree pruned back nearly to the trunk bearing a number of young shoots, badly affected and sprayed first in December, showed but a trace of living insects. Other trees ten or fifteen years old, in an otherwise healthy condition, but badly incrusted with scales in December, when they were sprayed for the first time, showed no living scales on the trunk, lower limbs and branches. A few scales were found on the terminal branchlets. From these, scattered colonies of scales had formed on the fruit and leaves. It seemed evident that had these trees been cut back at the terminals before spraying, the single treatment in December would have nearly, if not wholly, freed them of scale insects.

The lime, sulphur, and salt wash employed in California has not been experimented with by this Station. Early in the spring of 1897, the writer assisted in the application of such a wash, in an orchard in Reno. He did not witness any of the steps in the preparation of the wash and cannot speak authoritatively upon this all important part of the work. The spraying of a number of very badly affected trees was thoroughly done, going over them twice in order to wet all parts of the trees. Examination three months later showed that while some of the insects might have been killed, too many remained to justify the labor and expense of spraying. The leaves and fruit were seemingly as badly infested as though no spraying had been done.

A short summary of the San Jose scale problem gathered from various sources, particularly from "The San Jose Scale, Its Occurrences in the United States," a publication from the U. S. Department of Agriculture, by L. O. Howard and C. L. Marlatt, 1896, would embrace the facts that the San Jose scale is considered the worst insect enemy of the deciduous fruits known; that it is very rapidly spreading to all parts of the country; that it does not yield uniformly to the same methods of treatment in different parts of the country having different climatic conditions; that successful methods in vogue in California do not give satisfactory results in the east; that the methods most likely to prove effectual in Nevada will probably prove to be more like those employed in the east than in California, and that until other methods now frequently recommended are demonstrated to be adapted to more general application, the winter wash of whale-oil soap properly applied, at the proper strength, is the most reliable.

It will be noted that whale-oil soap has been employed in the experiments of this department at the single strength of two pounds of soap to one gallon of water.

Experiments by the Division of Entomology, U. S. Dept. of Agriculture, in which three pounds of whale-oil soap to one gallon of water were used resulted fatally to all the insects. With two pounds of soap to one gallon of water, all the insects were killed in one case, and 95 per cent in another. With less than two pounds to the gallon, not all were destroyed in any instance. In an experiment with pure kerosene oil upon two apple trees in January the insects were all killed, as were the trees also by the following spring.

A fungus disease of the San Jose scale in Florida is reported upon at length by Prof. P. H. Rolfs, in Florida Exp. Sta. Bull., No. 41, 1897. Though this disease is widely distributed geographically, it is not probable that it would prove effective in Nevada, owing to the dry climate.

Various predaceous insects destroy many of the scales in certain parts of the country. Of these, a hemispherical "Lady-bug" *(Chilocorus bivulnerus)*, shining black with two red spots on the back, has been observed by the writer as feeding upon scale insects here, both the San Jose scale and the English walnut scale.

No. 32.

ENGLISH WALNUT SCALE—*(Aspidiotus juglans-regiæ)—Diagnosis:* Boxelder and cottonwood limbs and branches are killed by this insect. The branches assume a spotted appearance, due to the diseased condition of the bark, and finally die. While still alive, the young branches are green colored, or even darker from the discoloration of the disease. Then the light colored scales of the insect are easily distinguished against the darker back ground. The female scales are irregularly circular, larger than those of the San Jose scale, raised toward the eccentric axis, light gray colored, a darker band surrounding the axis, which is brick red or light colored by the presence of a thin covering. The scales are often much crowded, a mature female scale frequently covering several half grown scales. In the case of older branches that have been killed, the bark having faded, the dead scales are hard to distinguish except by the scurfy condition they produce. From such branches they loosen and fall readily.

This insect has not become conspicuously injurious here as yet. Boxelder and cottonwood trees in different parts of Reno are affected. Individual limbs have succumbed to their attack while the remainder of the tree shows no signs of their presence.

While no experiments have been made with remedies for this insect by the department, it is quite probable that the remedies for the San Jose scale would prove effective against this species. Like the San Jose scale, this species occurs on a number of different plants.

No. 33.

OYSTER-SHELL BARK LOUSE—*(Mytilaspis pomorum)*—*Diagnosis:* The bark of various trees infested by these scale lice presents a spotted appearance, the spots being the lice and their egg protecting scales. These are about an eighth of an inch long, rounded on the back, pointed at one end, becoming broader towards the other end which is rounded, and are either straight or curved. The color is brownish, the body proper forming the pointed extremity. Their conspicuousness is dependent upon their number and the color of the bark on which they are found. They may occur scattered over the bark or so closely crowded as to overlap one another, considerably modifying their size and form. These are the mature female lice which attain maturity and die in August. The larger brown portion of the scale then contains a great number of eggs, easily seen on over-turning one of the scales. The eggs hatch in May or early June, the young lice scattering over the bark. The old dead scales remain fixed to the bark for a long time without material change still covering the empty shells of former eggs.

This has long been a well known insect in the east and central west where it has been a generally recognized pest of the apple. It occurs also upon other fruit trees and shrubs, also upon various ornamental trees.

It has not thus far been found on fruits in Nevada. It has been taken by the writer, however, on the Lombardy poplar in the streets of Carson City. This was in September, 1896. A number of these trees in one locality are thoroughly infested.

Owing to the preference of the insect for the apple, demonstrated in the east, we may reasonably expect it to eventually become an apple pest here, particularly since it is already well established within our State in at least one locality and possibly in many others.

This insect should not prove difficult to control. Spraying whale-oil soap upon infested trees in late autumn should so loosen the scales as to result in fatal exposure of the eggs to the winter's dampness and cold. Kerosene emulsion or strong soap mixture employed in spring immediately after the young have appeared should prove effective.

No. 34.

LECANIUM BARK LICE—These insects occur on a number of trees and shrubs in our region and possibly represent several distinct species. They are sufficiently similar, however, to be characterized together. *Diagnosis:* The Lecanium scales are most frequently met as reddish or dark brown, flattened, saddle-shaped, or hemispherical bodies, from one-eighth to one-quarter of an inch in diameter, attached to the branches or stalks of trees or shrubs. Old dead scales are brittle and fall away readily, exposing the empty egg-shells as a whitish dust beneath. Early in summer the young may be seen slowly moving over the bark in the vicinity of the old scales.

The locust trees about the streets of Reno, while seemingly not evidently affected by these insects, often exhibit them in immense numbers closely crowded upon the branches on the lower side causing them to present a conspicuously knotted appearance

Lecanium ribis is frequently found here on the stalks of the currant and gooseberry, yet not in sufficient numbers to do evident damage, however.

Whale-oil soap spray of good strength applied early in the season when the young lice have hatched would doubtless be found an effective remedy. It may be stated that a parasitic fly destroys many of them, living within the body of the insect, and leaving a hole the size of a small pin at the point of its escape from the body wall.

No. 35.

COTTONY MAPLE SCALE—*(Pulvinaria innumerabilis)*—This insect is closely related to the Lecanium scales from which it differs conspicuously in the presence of a cottony egg mass larger than the scale proper. *Diagnosis:* Boxelder trees exhibit this insect upon the branches. The body of the insect proper forms a somewhat flattened, oblong, saddle-shaped object, reddish brown in color, and nearly an eighth of an inch long. Out from beneath one end of this there projects a white cottony mass two or three times the size of the insect proper. This protects a mass of minute creamy eggs in summer. If pulled out it presents a stringy appearance.

Only the boxelder seems to be infested here, though elsewhere its near relative, the maple, is commonly infested, as is also the grape.

No. 36.

IMPORTED ELM BARK LOUSE—*(Gossyparia ulmi)*—*Diagnosis:* Infested elm trees exhibit dirty grayish rows and patches of old dead insects and their secretions along the lower side of the branches, evident for a distance of several feet or yards from badly infested trees where the disease has been in progress for two or three years, or longer. Closer examination shows the shriveled dark brown bodies of the insects to be about an eighth of an inch long, each surrounded by a cup of whitish or dirty gray waxy material, and often many white oblong cocoons a sixteenth of an inch long intermingled with the others. Cracks in the bark are often thickly covered by the bodies of the insects. On smooth bark, they occur in patches, especially about the base of the branches.

The foregoing condition is most evident in autumn. At this time, many of the young are distributed over the leaves. Later they return to the branches and may be found clustered, as above stated. In late autumn and early spring they appear as minute gray objects which move about sluggishly when disturbed.

Trees long affected are likely to show dead branches and in this way, perhaps, give the first intimation of the presence of the disease.

A further statement of the nature of this insect and its life-history is to be found in Bulletin No. 28 of this Station, which gives an account of the discovery of the insect at the Capitol grounds at Carson City.

No new infested locality has been discovered since that described in the above cited bulletin.

Following the suggestions offered by this department, Mr. C. A. LaGrave, State Comptroller, had the elm trees on the Capitol grounds thoroughly sprayed in March, 1896. The wash employed consisted, essentially, of a kerosene emulsion containing, as prepared for this particular occasion, 3 pounds of whale-oil soap, 6 gallons of kerosene emulsified in 3 gallons of water, then diluted to form 45 gallons of the mixture.

A bundle of infested branches sent to the writer a few days after treatment, failed to show a single living insect, while thousands had been killed by the emulsion. A careful examination of the trees by the writer in the following September resulted in his inability to find a sufficient number of the insects of the brood of 1896 for study. Later, however, some living insects were found and sent to the department for examination. That some, or even many, should have escaped the treatment is not surprising when the size or the trees, which were mostly 40 or 50 feet high, and the probable inexperience of the workmen, are taken into consideration. The results may be considered very satisfactory as showing what may be expected from this mode of treatment under favorable conditions.

This insect has not yet become generally distributed throughout the country, but to show that it is important to keep it under control, it may be stated that it has been reported from several points within the United States. Prof. G. H. Perkins states in the annual report of the Vermont Agr'l Exp. Sta., for 1889, that this is one of two or three insects that "have proved especially injurious" to the elm; also that it was common on the elms at Burlington. In Bulletin No. 28 from the Mass Agr'l Exp. Sta., 1895, Mr. C. P. Launsbury states that this insect had become very common, also that young American elms had been almost destroyed by it. As a remedy, kerosene emulsion, only when very strong, proved effective. The emulsion contained ½ pound of common bar soap, 2 gallons of kerosene, and one gallon of water. A gallon of this was diluted to make 3 gallons of the prepared mixture.

No. 37.

ROSE LEAF HOPPER—*(Typhlocyba rosæ)*—*Diagnosis:* A whitish spotted condition of rose leaves, giving them a gray appearance, indicating the presence of numerous white insects feeding upon their lower surface, is very common about Reno.

These insects represent one of many kinds of closely allied insects that infest the lower surface of the leaves of numerous plants. By means of their tiny beaks they suck the nourishment from the leaves, destroying the tissue contents at the points of injury, resulting in the spotted aspect of the upper surface. When disturbed, these insects hop to an adjacent leaf so that one needs to use a little caution in order to observe them at their work.

The injury from these insects can be prevented by spraying the plants from beneath, with kerosene emulsion, or dusting them frequently with buhach or white hellebore.

No. 38.

BUFFALO TREE HOPPER—*(Ceresa bubalus)*—*Diagnosis:* The upper branches and twigs of young fruit trees are frequently scarred and roughened from the presence of oval slits in the bark, varying from an eighth to a fourth of an inch in length. The slits extend lengthwise of the twig, and, at first, constitute a pair of slightly incurved incisions, side by side. The bark dies at the edges of the slits which then expand, leaving, for a time, an intervening strip of bark which eventually dies and falls away. Healing begins at the sides of the slits, the young bark closing in towards the centre, the same as about the scar of an amputated branch. The surface becomes somewhat elevated in the process of healing, giving badly injured twigs a knotted appearance. Badly infested young trees soon assume a rough, scabby appearance.

This injury affects various fruit trees; the young ones most severely, the older ones being attacked principally on the younger growth; therefore the effect is not so noticeable. Various wild shrubs are also subject to injury. On the University grounds, young apple and cherry trees, willows, and a wild shrub *(Prunus Andersonii)*, are found to be severely infested.

The author of this injury is a greenish hump-backed bug, which, when viewed from above, is not unlike a beech nut in form. The female insect does the injury to the twigs in depositing her eggs, a row of which is placed in each of the two curved incisions forming a complete slit. In May and June the eggs hatch. The young insects feed upon vegetable substances during summer, maturing in August. From this time until October the puncturing of the twigs in the process of egg laying continues. The injury caused by the feeding of the young growing insects is probably insignificant as they prefer succulent vegetation, as weeds and the like; and, their numbers are, seemingly, never sufficient to permit them in this way to injure cultivated plants. Thus it is through their egg-laying habits that they become a pest of the orchard.

Judicious pruning may, in some instances, be beneficial in reducing the number of the insects. Owing to the migratory habits of the young insects, spraying is of little use.

Clean culture is the most effectual check to the prosperity of these insects. By keeping the orchard under cultivation and free from weeds, the young will be starved out and the enemy eventually driven from the orchard.

No. 39.

RED SPIDER—*(Tetranychus telarius)*—*Diagnosis:* The leaves of various trees and shrubs become spotted or turn yellowish or brownish, and exhibit a very fine web covering their under surface. Frequently minute greenish or reddish mites may be seen crawling over, or beneath, the web.

Twigs are often found covered by the webs of the mite.

In the winter and spring the eggs of the mite occur as minute globular objects in the crevices of, and beneath, scales of bark The eggs are reddish before hatching; those having hatched being represented by the white shells, intermingled with the others.

This mite is most commonly considered a pest of house-plants, as the dry air of rooms is more congenial to it than the more moist out-door air of most parts of the country.

The mite is not a true insect, being more closely related to the spiders It lives upon the sap of the plant, which it obtains by puncturing the under surface of the leaf with its very minute, piercing, mouth organs

Fruit trees, shrubs and also shade trees are very generally attacked in this region. Our long, dry summer and autumn are most conducive to the development of this pest. The browned, diseased, appearance of the leaves of fruit trees, currants and the elms is noticeable, particularly in western Nevada, during the latter part of summer and autumn. This condition is rendered the more conspicuous by the dust which these leaves, owing to their web covered surface, collect and hold, usually for a period of several weeks. During exceptionally dry seasons, this condition is likely to attract particular attention; and, it is a question whether the presence of the dust and dirt on the breathing side of the leaves is not as injurious as the direct injury of the mites.

Kerosene emulsion applied to infested plants in such a manner that the under surface of the leaves will be thoroughly wet, is an effectual remedy. Water alone, when it can be frequently applied, will often be found efficient.

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Notes for 1897.

NEVADA STATE UNIVERSITY

Agricultural Experiment Station

BULLETIN NO. 37.

RENO, NEVADA, DECEMBER 1897.

Agricultural Experiment Station

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NEVADA WEEDS.

III.

NEVADA AND OTHER WEED SEEDS.

F. H. HILLMAN, M. S.

INTRODUCTION.

The following pages upon the characters of weed seeds are presented in the belief that comparative immunity from many of our worst weeds may be secured by preventing the sowing and subsequent careful tillage of their seeds along with those of more desirable plants.

The character of the weed belonging to a plant soon comes to be known by the farmer who has to deal with pests of this kind in the field. If he practices clean culture, he is, doubtless, called upon to expend far greater effort in eradicating these plants than would be required in preventing their introduction were he able to identify their seeds and thus understandingly demand reasonably clean seed of the dealers. Such a course is believed to be feasible for the practical farmer, and the present article is offered as an aid to this end.

The employment of the matter presented here may offer, furthermore, an incentive to general clean culture, a phase of farm practice which is becoming more and more essential to success in agricultural pursuits.

THE SEED, IN ITS POPULAR SENSE.

The term "seed," in its popular sense, is that product of a flowering plant capable, on germination, of producing another individual of the same species as that from which it came. The act of germination is essential since the seed contains an essential *embryo*, or germ plantlet, to the early growth of which the term germination properly belongs. Hence the term "seed" in the common expression "seed potato" is incorrectly employed since no embryo is involved in the growth of the potato tuber, which is but a form of plant stem. Furthermore, the term seed, as commonly used, often includes more than the seed proper, as recognized in its botanical sense. Thus in many instances it includes, also, the persistent seed vessel and even other organs of the flower or flower cluster. Such seeds are known, botanically, as *fruits*.

The occurrence under these various guises of many of the weed seeds necessitates their consideration preparatory to a proper understanding of the following descriptions and illustrations.

THE SEED PROPER.

The seed, in the restricted sense of the term, consists of a *kernel* enclosed by two coats, rarely by but one. The outer coat, which is the thicker and more enduring, presents the various characters of form and sculpturings peculiar to the seeds of its kind; and, more or less evidently, the "scar" (*hilum*), the point where the seed was attached to the mother plant. The inner coat is thin, often obscure, and usually of no importance in classification. The kernel consists essentially, either wholly or in part, of the *embryo*. In the latter case, the remaining portion of the kernel constitutes the *endosperm*, often termed *albumen*. This is the store-house of nourishment required by the embryo. In the absence of the endosperm, the nourishment is stored within the embryo. The presence or absence of the endosperm gives rise to the terms *albuminous* and *exalbuminous*, respectively, which are employed to designate the seeds of these two types. The seeds of Prickly Poppy, Cow-herb and Black Nightshade are albuminous, while those of Mustard and Pepper-grass are exalbuminous.

The embryo is the germ plantlet. The simplest typical form of embryo exhibited by the weed seeds is that of a straight cylindrical body. It is cleft for a part of its length from one extremity forming the seed leaves (*cotyledons*). The remaining portion constitutes the plant stemlet (*caulicle*, formerly termed *radicle*). At the base of the cotyledons, and between them, is a minute bud (*plumule*) from which the stem of the future plant is to develop. The seed of the Evening Primrose and the Black Bind-weed illustrate this simple form of the embryo.

Various modifications in the form of the embryo occur, most of which are very characteristic of the weed seeds in which they are found These modifications include the curved cylindrical embryo, a very common form, as in the seeds of Lamb's-quarters, Cow-herb and Purslane; the spirally coiled embryo, as in Dodder and Corn Spurrey; embryos with leaf-like cotyledons, as in Mallow and Stork's-bill; embryos of exalbuminous seeds exhibiting a marked thickening of the cotyledons, due to the presence of nourishment, as in Mustard; and, embryos associated with copious endosperm having relatively small cotyledons, as in Prickly Poppy and Wild Tobacco.

The relative positions of the caulicle and cotyledons in the folded embryos of some families, as the Cruciferæ, often afford a character of importance in classification.

The position of the embryo with respect to the endosperm differs widely in the seeds of many weeds not closely related. The constancy of this character often gives it value as an aid in making identifications. The embryo may be wholly surrounded by endosperm, as in the Prickly Poppy; it may encircle the endosperm, as in Purslane and many others; or, it may rest on one side of it, as in Knot-grass and Dock.

Furthermore, the relative quantity of endosperm varies much in different kinds of seeds. Thus in the Prickly Poppy a large quantity of endosperm is present, while in the Mallow a small amount is associated with a relatively large embryo.

THE FRUIT.

When the seed proper is enveloped by the persistent seed vessel (*pericarp*), the term *fruit* is applied to the whole. In technical language the terms *akene* and *nutlet* are employed with reference to certain seeds invested singly by a close fitting persistent seed vessel. In such cases the seed vessel assumes all the characteristic markings by which such "seeds" are commonly recognized. The seeds of the Composite family illustrate the akene; those of the Borage family (*Amsinckia* and Blue-weed) illustrate the nutlet. The term *bur* is applied to a few seeds enclosed by a bur-like covering often consisting of the parts of the persistent flower cluster, as the Clot-bur and Spiny Clot-bur. Persistency of different floral organs is exhibited by the seeds of some weeds, as in Lamb's-quarters. This permits these seeds to appear in different guises among commercial seeds—a fact to be borne in mind in seeking their identification.

DISTINGUISHING CHARACTERS OF WEED SEEDS.

The most evident characters by which weed seeds are to be distinguished may, perhaps, be summarized in the order of their conspicuousness as follows: Size, form, color, structural markings and capability to develop a coat of mucilage in the presence of water. Great differences in each of these classes of characters are exhibited by seeds of distant relationship, and sometimes by those of closely related plants. The kernel structure is less evident, but often decisive.

Size and form are apt to vary considerably in individual seeds of the same kind or species when they are produced in considerable number in the same seed vessel, and thus are more or less crowded during development. Again, size is subject to variation due to different conditions of development of the plants producing the seeds. Form is most constant for seeds produced singly or in small number by each flower.

Color is fairly constant for most kinds and very constant for many when mature well developed seeds are considered. Immature seeds are often lighter colored than mature ones of the same kind. The shining of seeds may be classed here, though it belongs more properly under the next head. This is the result of the absence of microscopic roughness over the whole or a part of the seed coat, permitting a reflection of light. Various degrees of this character are exhibited. These are, however, very constant for the seeds to which they belong, when they have not been subjected to unusual influences, as the oiling of seeds or the wetting of mucilage producing seeds.

Structural markings, or sculpturings, are, ordinarily, very constant in seeds of the same kind and very different in those of different kinds, particularly when they are not closely allied. This character. therefore, becomes one of the greatest value in the determination of the identity of most of the weed seeds. These sculpturings include ridges, grooves or striations, wrinkles, pits, teeth, tubercles, smooth and granular surfaces and winged margins or other appendages. To these might be added various markings due to internal structure. Several of these forms may be exhibited in the individual seeds of the same kind. "Smooth" and "granular" are relative terms which, as used in the following descriptions, are to be interpreted in their popular sense based upon the appearance of an object under the ordinary magnifier enlarging to about ten diameters.

Some seeds are capable of developing a coat of mucilage from the outer seed coat in the presence of water. Immersing such seeds in water results in the appearance, in a few moments, of a white or transparent covering of mucilage. If transparent, it is very evident in causing the seeds to appear unable to touch each other. When removed from the water and permitted to dry, they will be found tightly adhering to the surface upon which they were placed. Owing to this property, certain weed seeds occurring with commercial seed are frequently found sticking together or to other seeds, or having particles of other materials adhering to them, the result of having become wet before being placed on the market.

DISTRIBUTION OF WEED SEEDS.

The modes by which weed seeds are carried from place to place and the distribution of their plants thus secured, vary greatly, dependent upon the structural and other characters exhibited by various kinds of seeds. Many weed seeds are admirably adapted for transportation by the wind. Some are provided with a plume of downy "*pappus*," as the akenes of Dandelion and Prickly Lettuce. The seeds proper of the Milkweeds and some others are provided for the same purpose with a tuft of fibres (*coma*) Some have a thin wing-like margin, others slender awns, all serving to increase the buoyancy of the seeds, permitting them to be carried long distances by the wind. The seeds of the "tumble-weeds" (as *Amarantus albus*) are scattered by the rolling of the ripened plants over the ground by the wind. Many seeds are blown long distances over the snow and carried in drifting snow. Burs become attached to clothing and the coats of passing animals. Straw and hay used for packing are apt to contain much foul seed. The same may be said of bedding and food employed in shipping stock. Many light buoyant seeds are carried by the water of streams. This is particularly true of irrigation ditches. Clover seed, grass seed and the seeds of the grains are recognized conveyers and distributers of weed seeds, the nature of which is dependent upon the source of supply of these seeds, the similarity of the weed seeds, respecting weight and size, to those with which they are associated, and the degree of thoroughness with which the latter were cleaned when threshed.

THE EXAMINATION OF COMMERCIAL SEEDS TO DETERMINE THE PRESENCE AND CHARACTER OF WEED SEEDS.

Samples of field seeds to be examined may be spread, a small quantity at a time, upon a white surface, as a dinner plate or a sheet of paper, allowing the seeds to fall two or three inches by which they scatter evenly. The presence of most of the weed seeds likely to be found in such samples is usually evident to the unaided eye. Their identification, however, will usually require the aid of a magnifier, at least until one becomes familiar with their general appearance without magnification.

Suitable magnifiers, as shown in Figures 1 and 2, are to be had of the Bausch and Lomb Optical Co., Rochester, N. Y., or their agent in San Francisco. Very fair magnifiers are to be had of opticians and stationers generally. The ordinary prospector's lenses do very well.

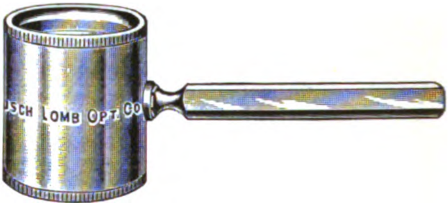

Fig. 1.

The external appearance of most of the seeds discussed in this article should suffice to reveal their identity. Should it be necessary to resort to dissection, the seeds should be soaked in water for a few hours; or, if desired, greater haste is secured by boiling them for a few minutes. Prolonged boiling often causes the parts of the seed to separate sufficiently to make satisfactory examination possible without subsequent dissection.

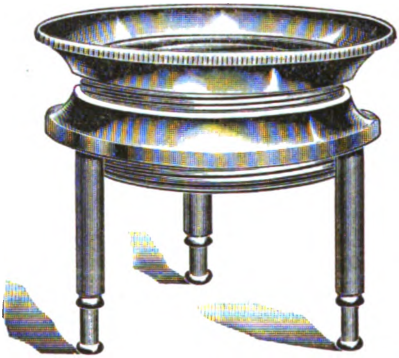

Fig. 2.

Fragments of weed seeds often occur with commercial seeds, when a knowledge of the structure of the kernel is helpful, and may be necessary for positive identification.

ILLUSTRATIONS AND DESCRIPTIONS.

The illustrations of seeds employed in the present article have been produced from original drawings from nature by the author, and are

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Fig 1.—A magnifier, very suitable for use in the examination of seeds. This is doubtless the best of the cheap glasses. The price is 75 cents.

Fig. 2.—Another form of magnifier adapted to seed examination, but not so readily carried in the pocket. It should be had for 50 or 75 cents.

intended to supplement the descriptions, which, in the absence of the illustrations, would doubtless fail in their purpose. In the production of the figures it has been the aim to avoid conventionality so far as possible, permitting them to express such characters as are evident under the ordinary lens magnifying about ten diameters.

The phraseology of the descriptions has been made as simple as is consistent with accuracy and conciseness. A few statements relating to the plants whose seeds are described are given in each instance to permit the association of the seeds with their proper plants.

Grateful acknowledgement is due the botanists of the American and Canadian Experiment Stations and the U. S. Department of Agriculture, and Dr. Friedrich Nobbe of Tharand, Saxony, whose writings have been a constant source of helpful reference during the preparation of the following pages.

F. H. H.

RENO, NEVADA, September, 1898.

DESCRIPTIVE LIST OF WEED SEEDS.

[The sequence of families adopted is that of Gray's Manual, 6th Edition.]

Among the common weed seeds occurring with grass seed, are those of Buttercups, *Ranunculus*, plants of frequent occurrence in eastern meadows and pastures. Most of the different kinds of Buttercups prefer moist ground and often the fields assume a bright golden aspect due to the profusion of flowers of these plants. Two kinds are commonest, *Ranunculus acris* L. and *Ranunculus bulbosus* L. These plants differ in size considerably, the former being two or three feet high, while the latter is commonly about half as tall, its stem, unlike that of the other, being thickened and bulb-like at the base.

The *seeds* (akenes) of the Buttercups, as found in commercial seed, may represent several different species, including those mentioned above. They are, in general, flattened, more or less lens-shaped in section, brownish or even nearly black, sometimes reddish or purplish. The surface is dull and minutely granular, otherwise smooth, or, in certain species, somewhat tubercled. The form is somewhat unsymmetrically oval or sometimes nearly circular. The size varies from one-twelfth to one-eighth of an inch in length. One extremity is usually tipped with a short, straight or curved appendage (the style of the flower) opposite the scar (point of attachment in the flower). The unequally curved margins connecting the scar and appendage are, in certain common species, distinctly beveled on each of the similar faces giving the akenes a margined appearance. This is often the more evident in the color of the margin being either lighter or darker than

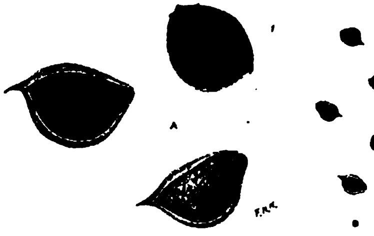

Fig. 3.

Fig. 3.—Seeds of Buttercups, *Ranunculus*. A, two or three different kinds of seeds (fruits) magnified. B, a group showing the natural size.

the rest of the surface. Within the firm wall of the akene is the single flattened seed proper attached near the scar.

These seeds are very common in the lawn mixtures and the rye grasses, and, doubtless, with a good many other kinds of seeds. The size of the seeds found is very dependent upon that of the seeds with which they occur. They are often very small in lawn mixtures.

The PRICKLY POPPY, *Argemone hispida* Gray, is not a pernicious weed. Its conspicuous white flowers and light green, thistle-like, prickly herbage serve to distinguish it from other plants of our region.

The *seeds* are almost spherical, barring a ridge ("crest") along one side The crest does not, however, prevent the seeds from rolling readily on a level surface, but usually assumes a lowermost position when the seeds are at rest. The presence of the crest often gives the seeds a somewhat oval outline. They are approximately one-twelfth of an inch in diameter The color varies from light to dark brown or even black; or, they may present a steel gray color due to the reflection of light. The surface presents a a rather coarse network of ridges. The intervening spaces are more or less distinctly arranged in curved rows connecting the ends of the crest. The surface of these depressed spaces is smooth and in many seeds has a distinct luster, giving the steel gray appearance referred to above. The mesh of the network of ridges is finest immediately about the crest. The indistinct scar is at the more pointed extremity of the crest. The embryo is small and slightly curved and is imbedded in a copious endosperm: also, it is situated near the scar to which it points.

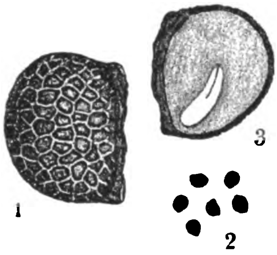

Fig. 4.

The seeds of Prickly Poppy are not likely to occur frequently with commercial seed owing to the plant's habit of growth.

The Mustard Family, *Cruciferæ*, is, economically, one of the most important of the natural families of plants. It contains, besides many highly valued garden and field vegetables, a number of the most pernicious weeds of agriculture. Some are particularly well adapted for dissemination and are rapidly becoming dangerously common in many

Fig. 4.—Prickly Poppy, *Argemone hispida* 1, a seed, enlarged, showing the crest at the right. 2, a group of seeds, natural size. 3, a section of the seed through the crest showing the small embryo imbedded in the abundant endosperm.

of the newer and more promising agricultural regions of the West. The similarity in size and weight of the seeds of most of these weeds to those of various grasses and clovers, results in their being very commonly associated with these commercial seeds. Again, the fact that the seeds of most of the weeds of this family develop a coat of mucilage when wet, permitting them to adhere firmly to any object they may touch while in this condition, further illustrates the subtle and widespread dissemination to which these plants are subject. The great quantity in which their seeds are produced, and the hosts of plants which are often developed, make the control of these weeds very difficult and emphasizes the importance of preventing their introduction through the recognition of their seeds.

Most of the weeds of the Cruciferæ are upright plants with entire or more or less segmented leaves. The branches bear the seed pods along their sides, forming slender clusters called racemes. The flowers are mostly clustered at the branch tips. The identity of the plants is most evident in the form of the pods, leaves, flowers and seeds.

The *seeds* are mostly small. The surface is dull or but slightly glistening and usually more or less granular. All are without endosperm (*i. e.*, exalbuminous). The thin seed coats fit the embryo so closely that the form of the latter is, with a few exceptions, easily discernable upon external examination. The embryo is folded upon itself, causing the cotyledons to assume one of two or three very characteristic positions with respect to the caulicle. They may rest with one edge against the caulicle (accumbent), with the back of one against the caulicle (incumbent), in a position diagonal to each of these (oblique), or incumbently and folded lengthwise (conduplicate) These positions are usually more or less evident in the external form of the seed and indicate the family membership of these seeds.

Seeds under examination suspected of belonging to this family should be tested in water for mucilage. This is mostly transparent, usually with radiating lines, indicating different densities, evident when observed by transmitted light. In some species a copious amount is formed, in others only a thin coat. Upon the drying of seeds that have been wet, a film or strings of mucilage remain firmly holding the seeds to the adjacent surface. In some instances a surface covering of hair-like points or threads remains.

The taste of the seeds is often worthy of being tested.

FALSE FLAX, *Camelina sativa* Crantz, is an annual plant which has come to us from Europe. There it has long been a weed of flax fields, from which fact it has derived its popular name. While it is rather generally distributed over the United States, it is becoming a recognized pest of grain and flax districts of the northwestern States and the adjoining British possessions.

This plant has spread rapidly about Reno within recent years. Formerly it occurred in a few restricted patches only; now, like Shepherd's Purse, it is to be found almost "everywhere." Its thickened pear-shaped pods distinguish it from the other weeds of its class.

The *seeds* are small and robust, approximately one-twentieth of an inch in length, the size somewhat variable. Typical specimens are broadly oval and slightly flattened. Others are narrower or more or less angular in outline. The whitish scar at one extremity occupies a slight notch between the caulicle and cotyledons. The groove between the caulicle and cotyledons is evident along one side of each of the slightly flattened faces, that between the cotyledons but slightly or not at all evident. The surface is finely but evidently granular, and dull or faintly glistening in some instances. The color is uniformly reddish yellow, somewhat darker about the scar. A copious coat of transparent mucilage having radiating lines is developed in water. The cotyledons are typically incumbent. The seeds are not pungent, but a few of them taken together have a somewhat turnip-like taste.

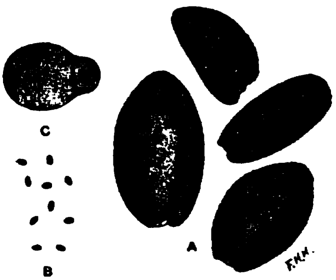

Fig. 5.

The seeds of False Flax are frequently associated with grass and clover seeds, and probably with flax seed. The smaller specimens are apt to be confounded with those of Shepherd's Purse. They should be distinguished, however, by their more robust form and more coarsely granular surface.

WINTER CRESS, *Barbarea vulgaris* R. Br., called also Yellow Rocket, is a plant of very general distribution throughout the United States. It is not at all aggressive in western Nevada, and as it seems

Fig 5.—False Flax, *Camelina sativa*. A, a group of seeds, enlarged, showing the prevailing forms and relative sizes. B group indicating the natural size. C, a cross section of a seed showing the incumbent character of the cotyledons.

to be indigenous in the mountains, it may not become so. Its rather rigid stems, upright four-sided pods, bright yellow flowers and usual occurrence in damp places should distinguish this plant from others.

The *seeds* are broadly oblong, flattened and somewhat thickened at the centre, the faces sloping slightly to the rounded margins. They are approximately one-sixteenth of an inch in length, and are rather constant in size and form. The surface is finely roughened by a delicate and somewhat indistinct network of ridges. A thin, light colored, ordinarily rounded, appendage at one extremity indicates the scar. A more or less evident groove extending from the scar for a part of the length of one face indicates the position of the caulicle. The color is light brown, the surface dull or glistening slightly. The cotyledons are thin and parallel with the faces of the seed. They are accumbent or sometimes slightly oblique to the slender caulicle. The seeds do not develop a distinct coat of mucilage in water, and the taste is not pungent.

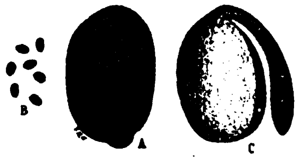

Fig. 6.

The seeds are very apt to occur among grass seeds, as the plants are adapted for growth in damp meadows.

The WESTERN WALL-FLOWER, *Erysimum asperum* DC., known also as Treacle Mustard, is a common plant throughout the West. In the Northwest it is ranked as a distinct weed. It occurs in Nevada, but nowhere, so far as the writer knows, is it sufficiently common to justify its consideration as a noxious plant. As yet, it seems confined, in the main, to wild land; but the fact that the plant possesses weedy properties elsewhere warrants a careful consideration of its seeds. The plant stands one or two feet high, its flowers yellow and rather large, the pods slender and spreading.

The *seeds*, as represented by well matured specimens, are narrowly or broadly oblong, flattened and plano-convex, the extremity bearing the scar somewhat truncate. They are approximately one-sixteenth of an inch in length, varying somewhat both in size and in form. The surface is smooth, in general, the convex face faintly striate lengthwise, the plane face having a finely uneven surface. The extremity opposite

Fig. 6.—Winter Cress, ***Barbarea vulgaris***. A, a side view of a seed, enlarged. B, group showing the natural size. C, the embryo showing the slender caulicle and nearly accumbent cotyledons.

the scar bears a thin, rounded, light colored wing which may be reduced to a mere trace or even be wholly wanting. Often a membrane at the scar is nearly as prominent as the wing and much likened to it in appearance. The color of the seeds is light reddish yellow, usually distinctly darker at the extremity immediately about the scar. They are dull or glisten slightly under the lens. The cotyledons are commonly oblique to the caulicle. This results in the appearance on the convex face of one or two longitudinal grooves near one edge; and, on the plane face, of two grooves dividing the face into three nearly equal parts, the grooves nearly uniting near the winged extremity. The seeds develop a moderate amount of transparent mucilage having radiating lines, when placed in water. They have a distinctly bitter taste, evident in even one or two seeds.

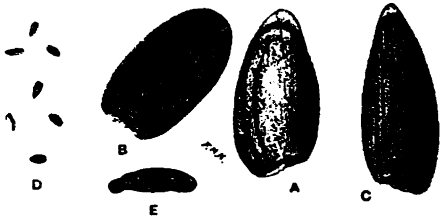

Fig. 7.

While the seeds are not common in commercial seed, they may be found in such seed from the Northwest.

WORM-SEED MUSTARD, *Erysimum cheiranthoides* L., also called Treacle Mustard, is a weed of grain fields, particularly in the northwestern States, where it is reported as having very much the same habits as its near ally, *Erysimum asperum*. It is not known to occur in Nevada as yet.

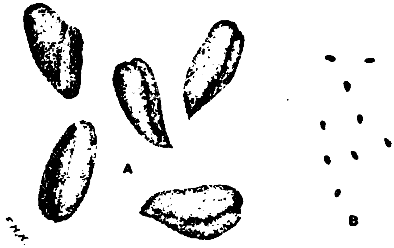

Fig 8

The *seeds* of this species are very much smaller than those of the Western Wall-flower. They approximate one-twenty-fourth of an inch in length, and are quite variable both in size and

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Fig 7.—Western Wall-flower, *Erysimum asperum*. A and C, the convex face of two common forms of wing-tipped seeds. B, the plane face of a wingless seed. D, group of seeds natural size. E, cross section of a seed similar to A or B.

Fig. 8.—Worm-seed Mustard, *Erysimum cheiranthoides*. A, a group of seeds, enlarged, exhibiting the prevailing forms. B, group showing the natural size.

form. These seeds indicate development under considerable compression, hence the variability in form. Many are acutely pointed at the extremity opposite the scar, some of them being the more pointed owing to the presence of a minute reduced wing. The caulicle is usually distinctly evident. In some seeds it lies parallel to the cotyledons, and in others it is placed obliquely across them. In general, the relative positions of the cotyledons and caulicle are the same as in *E. asperum.* The surface is smooth without striation, and dull. The color is light reddish yellow or occasionally greenish, the extremity at the scar conspicuously darker. A slight coat of transparent mucilage forms in water, and even a few specimens give a distinctly bitter taste.

Grass seeds and the smaller clover seeds from the northwestern States are apt to contain seeds of this species.

The HEDGE MUSTARDS, which belong to the genus *Sisymbrium*, are becoming prominent as weeds in the West and Northwest. The several kinds of plants which they represent resemble each other somewhat, but do not all share the same distribution. Three are common in Nevada, while a fourth occurs in one locality, at least, where it was introduced, probably from California, where it is very common. Another is one of the worst weeds of the Northwest.

Sisymbrium incisum Engelm., has no popular name, especially referring to it, established as yet. As a weed, it has received little attention from botanical writers. In Nevada, however, it has spread rapidly within recent years and has become one of the commonest of weeds along roadsides, in fields and in neglected places. Its deep green herbage and dense finely divided leaves, combined with its erect pyramidal habit when young, give an area devoted to this plant quite the appearance of a miniature pine forest. Later, the branching top, loaded with pods, develops an immense quantity of seeds, which the Indians are said to gather for food.

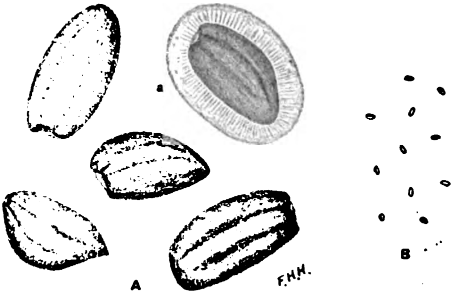

Fig. 9.

Fig. 9.—A Hedge Mustard, *Sisymbrium incisum*. A, a group of seeds, enlarged, showing the common forms. **a**, a seed showing the appearance of the mucilage while wet. B, group of seeds, natural size.

The *seeds* are minute, approximately one-twenty-fourth of an inch in length, and somewhat flattened. They are usually oblong in outline, but commonly obliquely compressed at the extremity opposite the scar. This is due to their lying closely in a single row in each cell of the pod, and thus subject to considerable longitudinal pressure during development. Also, they vary somewhat in size and form. The groove between the caulicle and cotyledons is evident, that between the cotyledons usually so. The minute whitish scar occupies a slight notch at one extremity between the cotyledons and the usually slightly projecting tip of the caulicle. The scar membrane is not usually sufficient, however, to give a distinctly pointed appearance to this extremity of the seeds as is usual in the seeds of Shepherd's Purse. The surface is very finely granular, with the faintest trace of longitudinal striation, and dull. The color is reddish yellow, darker immediately about the scar. The caulicle is rarely curved about the cotyledons, which are incumbent or sometimes slightly oblique. These seeds produce a copious coat of transparent mucilage in water. They have no characteristic taste.

These seeds are so similar to those of Shepherd's Purse that only the typical forms of each species admit of being distinguished.

If this plant continues to develop its tendency to invade meadows, as seems probable, its seeds will doubtless become a common ingredient of commercial seeds, as is true of their counterparts, those of Shepherd's Purse.

Tansy Hedge Mustard, *Sisymbrium canescens* Nutt., is a somewhat similar but more generally distributed plant having lighter herbage and more open habit of growth. Its pods are shorter and more robust than those of *S. incisum*, and the seeds lie in two rows in each cell of the pod. It does not appear to be so aggressive as the other, yet it is a frequent intruder in open spots in alfalfa meadows.

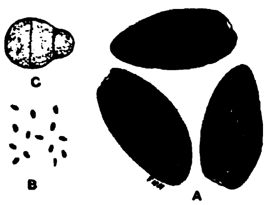

Fig. 10

The *seeds* are similar to those of *S. incisum*, but are commonly a half larger and more robust. The surface is more evidently granular and faintly striate. The tip of the

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Fig. 10 —Tansy Mustard, *Sisymbrium canescens*. A, a group of seeds, enlarged, indicating the common forms. B, group of the same, natural size C, a cross section of a seed showing the relative positions of the parts of the embryo usual in the seeds of *Sisymbrium*. (See a, Fig. 9, for the appearance of the mucilaginous coat.)

caulicle is usually more prominent, often producing a distinct notch at the scar. The color is reddish yellow, but normally darker than in *S. incisum.* The cotyledons are quite constantly incumbent. The coat of mucilage formed by these seeds is essentially the same as that of *S. incisum.*

The variety *brachycarpum* of this species is a lower, more spreading plant having egg-shaped pods. Its seeds are practically indistinguishable from those of the species.

Sisymbrium officinale L., the HEDGE MUSTARD of writers, has the reputation of a weed in various parts of the United States. In California, it is very common, and it has been found about Genoa, Nevada. It is a dark green plant with straggling wiry stems, the tapering pods closely appressed to the stems.

The *seeds* are oblong, approximately one-twenty-fourth of an inch in length, distinctly flattened, and more or less irregularly angled owing to severe compression during development. The position of the caulicle is clearly evident. It may be parallel to the cotyledons or partially folded about them. The surface is finely granular and striate, also dull or glistening slightly. The color is reddish yellow, or darker in being tinged with green. When wet, a very thin coat of transparent mucilage is formed, which, on drying, gives the seeds a very fine-hairy appearance. Furthermore, these seeds have a slightly bitter taste.

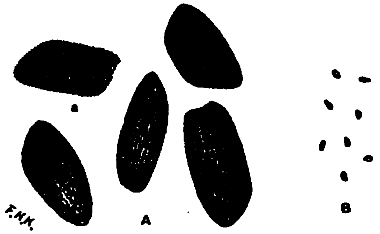

Fig. 11.

Commercial seeds of western production are very apt to contain these seeds.

TUMBLING MUSTARD, *Sisymbrium altissimum* L., is, doubtless, the most noxious of the Hedge Mustards. As yet, it is not known to occur as a noxious plant in Nevada. It is more especially a weed of the Northwest, including the British possessions. There, according to Mr. L. H. Dewey, of the Division of Botany, U. S. Department of Agriculture, this plant has become very troublesome. Further, that while it seems well adapted to the climatic conditions of western

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Fig. 11.—Hedge Mustard, *Sisymbrium officinale*. A, a group of seeds showing the prevailing forms. a, one showing the fine hair-like mucilage as it appears when wet or after drying. B, group showing the natural size.

Canada, it is also adapted to such varying conditions as will permit its growth over a wide range of territory.

This is a veritable "tumble-weed," the stems breaking off near the ground, after which the plants are blown about by the wind, scattering their seeds far and near.

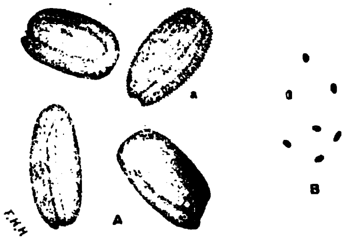

Fig. 12.

The *seeds* of this species are similar to those of the other Hedge Mustards. Like them, these are minute, approximately one-twentieth or one-twenty-fourth of an inch in length. They are flattened, mostly broadly oblong, or some of them angular. The surface is finely granular, scarcely striated, dull or slightly glistening. The color is reddish yellow; or, in some, strongly tinged with green. In the latter, the form of the embryo is clearly shown by lines of deeper green indicating the position of the cotyledons and caulicle. In others, the surface grooves show the form. The thin coat of transparent mucilage produced on wetting the seeds, forms, upon drying, a fine but distinct hairy covering over the surface. In this respect, these seeds are like those of *S. officinale.* These seeds have also a slightly bitter taste.

Mr. Dewey states, further, that the seeds of Tumbling Mustard may be distributed by baled hay, poorly cleaned seed, stock cars and the sweepings from grain cars.

The WILD TURNIP, often called Wild Mustard, *Brassica campestris* L., is a form of the ruta-baga and common turnip, which plays the role of a weed in grain fields, thin alfalfa fields and along roadsides. The more or less conspicuous yellow flowers, long slender pointed pods, and foliage having the light green of the common cabbage, serve to distinguish this plant as it appears in western Nevada.

The *seeds* are nearly spherical, rolling readily on a level surface. They vary in size from one-twentieth to one-sixteenth of an inch in diameter. The dull, light or dark reddish brown surface is roughened; and, in some instances, gives under the ordinary lens, the faintest

Fig. 12.—Tumbling Mustard, *Sisymbrium altissimum*. A, a group of seeds indicating the usual forms. a, one showing the hairy appearance due to the mucilage, either when wet or after drying. B, several seeds, natural size.

indication of a fine network of ridges. However, as compared with other species of *Brassica*, these do not have a reticulate-ridged surface. These seeds are practically indistinguishable from those of cabbage and turnip. The scar is evident as a whitish, often slightly elevated, spot. The position of the caulicle is sometimes evident in a slight protrusion of the surface near the scar. The cotyledons of the nearly spherical embryo are folded lengthwise (conduplicate), one of them including the caulicle. The seeds do not produce mucilage in water, and the taste is but mildly like that of Mustard.

These seeds are frequently found with the seeds of grasses and clovers. Their identification, when so found, as belonging to this weed form of the species, is justified by the difference in habit between this plant and its garden forms.

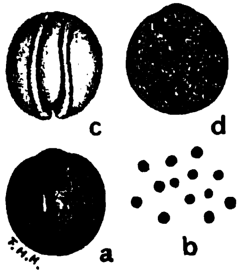

Fig. 13.

The BLACK MUSTARD, *Brassica nigra* Koch, may be a more generally recognized weed than the preceding, which it resembles in habit and general appearance. Its short, four-angled pods, closely appressed to the stem, and darker foliage should distinguish it from the other, however. The plant is rare in western Nevada.

The *seeds* are spherical, or more often broadly oblong, without being flattened. They are approximately from one-twentieth to one-sixteenth of an inch in diameter. The surface of well developed specimens presents a delicate but evident network of fine ridges which appear under the lens as dark lines. This gives the seeds an evident roughness of surface, while the intervening spaces are sufficiently smooth to glisten somewhat. The scar is a whitish elevated spot at one extremity of the oblong seeds. The color varies from light to dark reddish brown. The embryo is

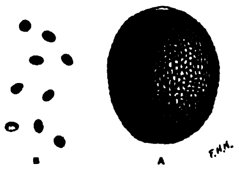

Fig. 14.

Fig. 13.—Wild Turnip, *Brassica campestris*. A, a seed, enlarged, showing the scar and external ridge indicating the caulicle. B, a group showing the variation in natural size. C, the embryo, showing the caulicle lying between the edges of the folded cotyledons. D, cross section of a seed, showing further the form of the embryo.

Fig. 14.—Black Mustard, *Brassica nigra*. A, a seed, enlarged; showing the surface network of dark lines. B, a group of seeds, natural size.

like that of *Brassica campestris*. The seeds do not develop mucilage in water, but they have a distinctly pungent taste which is evident in a single well developed seed.

These seeds are of frequent occurrence in grass and clover seeds.

The accompanying figure may be of aid in recognizing the seeds of some of the other Mustards, as English Charlock, *Brassica arvensis*, and Indian Mustard, *Brassica juncea*.

SHEPHERD'S PURSE, *Bursa pastoris* Weber, is a most cosmopolitan plant. Though it grows almost everywhere, its presence in alfalfa fields makes it a most noxious plant. It appears to be actually driving out the alfalfa in many places. Indeed, it is so reported by Professor Charles S. Crandall, in Bulletin No. 23, 1893, of the Colorado Agricultural Experiment Station. In two fields near Reno, recently observed by the writer, this plant was present in such quantity as to completely hide the young growth of alfalfa. In some fields, spots bare of alfalfa are wholly in possession of this plant. Shepherd's Purse grows one to two feet high, and its racemes of thin triangular pods are terminated by small clusters of white flowers.

The *seeds* are minute, approximately one-twenty-fourth of an inch in length. They are oblong and distinctly flattened, but not thin, and they present two similar faces. Each face, in typical specimens, bears two longitudinal grooves, though in some these grooves are merged into one. When the two are distinct, each face is divided by them into three nearly equal parts. These grooves indicate the position of the parts of the embryo. The scar is at one extremity to which it usually gives a well defined pointed appearance. The size of the seeds varies somewhat, the form remaining fairly constant. The surface is finely granular-roughened without striation. It is dull, or has a faint diffused luster under the lens. The color is reddish yellow, darker about the whitish scar. When placed in water, a copious coat of transparent mucilage is developed. The seeds have no characteristic taste.

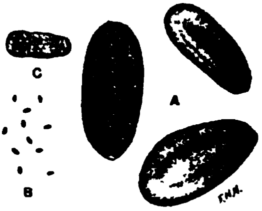

Fig. 15.

Fig. 15.—Shepherd's Purse, *Bursa pastoris*. A, three common forms of seeds, that at the left the most typical. B, a group showing the natural size. C; cross section of a seed. (See a, Fig. 9, for the appearance of the mucilaginous coat.)

These seeds should be distinguished from the similar small seeds of False Flax by their finer surface granulation and the presence of the double groove on their flatter faces. It is nearly impossible, however, to distinguish them from some of the seeds of *Sisymbrium incisum.*

The very general distribution of Shepherd's Purse results in the frequent occurrence of its seeds among the smaller grass and clover seeds.

PENNY CRESS, *Thalaspi arvense* L., known also as French-weed and Stink-weed, is essentially a weed of the grain fields of the Northwest. Professor James Fletcher states in correspondence that it is "the curse of Manitoba and the Northwest Territories." It is spreading eastward through the northern States and bids fair to become a weed of wide distribution. Its numerous and comparatively large winged pods and disagreeable odor permit the recognition of this weed of the Mustard family. This odor is said to have a very deleterious effect on the milk and meat of animals that have recently fed upon the plants. The plant has never been reported to the Station as occurring in Nevada, but its character is such as to justify effort to prevent its introduction through its seeds.

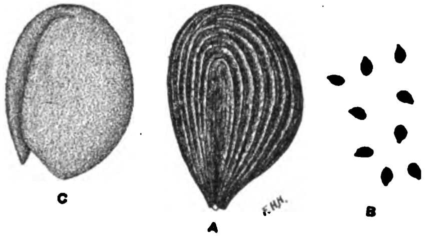

Fig 16.

Fig. 16.—Penny Cress, *Thalaspi arvense.* A, an enlarged seed, showing the characteristic surface ridges. B, a group of seeds, natural size. C, the embryo, showing the caulicle partially included by the accumbent cotyledons.

The *seeds* should be recognized easily by their form, color and markings. They are somewhat uniformly unsymmetrically egg-shaped in outline and much flattened with rounded edges, the two faces convex and similar. They are approximately one-twelfth of an inch long, but vary somewhat in size. The surface is roughened by characteristic curved ridges which originate and terminate at the more pointed extremity, and are rather eccentrically placed on each face. The ridges are, in all, about twelve or fourteen in number. They are mostly simple, but occasionally fork. The apex of each constitutes a dark line which is not very evident in dry seeds, but clearly defined in those that have been soaked or boiled in water. The surface is dull aside from an interrupted sharp reflection from the ridges. The color is rather uniformly deep reddish brown, darker at the smaller extremity, which is notched and indistinctly cleft to receive the whitish projecting particle at the scar. The cotyledons are broad and uniformly accumbent. No mucilage is formed in the presence of water. The taste, evident in several seeds, is slightly disagreeable, but not pungent.

The seeds are said to be readily distributed in grain and clover seeds, and thus may be expected to occur with such seeds produced in the North and Northwest.

The PEPPER-GRASSES constitute a small group of several species of *Lepidium*. They are mostly annual plants, but not, however, true grasses. One or another of these weeds represents the group in nearly all parts of the country. All are more or less similar in appearance and habit, and invade, alike, cultivated and neglected lands, meadows and roadsides, generally. In some localities they are especial pests of grain fields. The small, circular or egg-shaped pods and small, inconspicuous flowers serve to distinguish these plants from the other weeds of the Cruciferæ. The ability of the Pepper-grasses to take almost complete possession of certain lands through their wonderful seeding power, renders them most objectionable plants

The *seeds* of the more common kinds, like their plants are very similar, some of them being practically indistinguishable. Recognition of the seeds of one kind is gained by dissection; and, of another, by the size, form and color of the seeds.

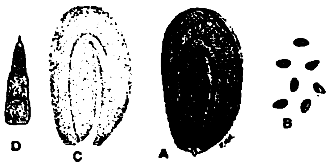

Fig. 17.

Two species, *Lepidium intermedium* Gray, and *L. medium* Greene, are common in western Nevada. *L. intermedium* seems to be indigenous, and grows everywhere. *L. medium* is, apparently, more in a state of becoming established, and would seem to possess even a more weedy tendency than *L. intermedium*. These plants have nearly circular pods. The flowers of *L. medium* have small white petals; those of *L. intermedium*, no petals or very small ones, shorter than the sepals.

Fig. 17.—Pepper-grass, ***Lepidium medium***. A, a side view of a seed, enlarged, showing the characteristic groove, and the narrowly winged margin at the right B, group of seeds, natural size. C, the embryo, showing its curvature within the cotyledons which are incumbent. D, a cross section of a seed. (See **a**, Fig. 9, for the appearance of the mucilaginous coat.)

The herbage of *L. medium* is sharply pungent and often purple tinged.

The *seeds* of these two kinds are too nearly alike to justify separate descriptions. Indeed, the following will suffice for the various Peppergrass seeds ususually found with commercial seeds (except in the case of the embryo of *L. Virginicum*, subsequently described). They are small, somewhat variable in size, but approximating one-sixteenth of an inch in length. They are somewhat unsymmetrically egg-shaped in outline, much flattened, often thin, the two nearly plane faces very similar. Of the two unequally curved edges, the straighter is thickened and somewhat flattened through the center, making a cross section of a dry seed at this point wedge-shaped, the opposite curved edge being thin. The latter edge often bears a narrow, light colored wing which may or may not extend across the broad extremity of the seed. Each face presents a curved longitudinal groove between the caulicle and cotyledons, and extending from the smaller extremity partly across the face A trace of a groove between the cotyledons is sometimes evident. The scar is indicated by a whitish, often projecting, particle at the smaller extremity. The surface is finely granular without striation, and dull. The color varies from light reddish yellow to reddish brown, the seeds often darker about the scar and along the edges. (Seeds which have once been wet usually remain darker.) The curvature of the embryo is within the cotyledons, each of which has a short stemlet. Thus the cotyledon stemlets, together, apparently increase the length of the rather short, pointed caulicle. The cotyledons are incumbent or sometimes slightly oblique. The seeds develop copious transparent mucilage in water. Fresh seeds of *L. medium* have a somewhat pungent taste.

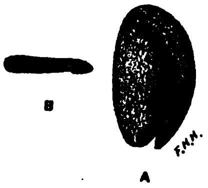

Fig. 18.

The seeds of one or another kind of Peppergrass very commonly occur with the seeds of grasses and clovers. Commercial seeds from the East are very apt to contain those of *Lepidium Virginicum* L., which differ essentially from the others in having accumbent cotyledons. By a twisting of the cotyledons, chiefly at the junction of the stemlet and broad portion, their edges are brought

Fig. 18.—*Lepidium Virginicum*. The embryo, enlarged. A, a side view, showing the accumbent nature of the cotyledons. B, the same in cross section.

against the caulicle, commonly in a slightly one-sided manner, often causing one side of the seed to be somewhat hollowed externally.

FIELD PEPPER-GRASS, *Lepidium campestre* R. Br., is reported as becoming a serious pest in eastern grain fields. The *seeds* are one-twelfth of an inch or more long, rather sharply egg-shaped and scarcely flattened. The surface is finely roughened and dull, and often has a mealy covering, evident against the dark brown color. These seeds develop a copious coat of mucilage from the thick, hard, outer seed coat, which asssumes a deep reddish color when thoroughly wet.

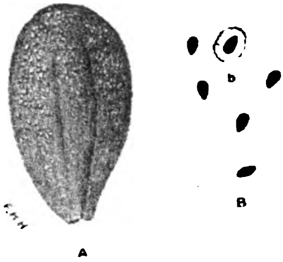

Fig. 19.

These seeds have been found with grass seed purchased in the East.

HARE'S-EAR MUSTARD, *Conringia orientalis* (L.) Dumort, is one of the later additions to the weed list of the Mustard family. Mr. L. H. Dewey, of the Division of Botany, U. S. Department of Agriculture, gives in Circular No. 10, 1897, of that Division, the distribution of this plant as then known. According to the localities given, its most prevalent occurrence is assigned to the States of the Northwest and the southern Canadian provinces. These include the Dakotas and Manitoba, where the plant is said to be spreading rapidly in the grain and flax regions. It is not known to occur in Nevada.

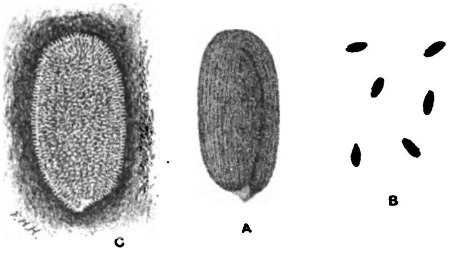

Fig. 20.

The *seeds* of Hare's-ear Mustard differ sufficiently from those of its weedy allies to be easily distinguished from them. They are oblong with rounded ends, scarcely flattened, approximately one-twelfth of an

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Fig 19.—Field Pepper-grass, *Lepidium campestre*. A, an enlarged side view of a seed. B, group of seeds, natural size. **b**, one indicating the mucilaginous coat.

Fig. 20.—Hare's-ear Mustard, *Conringia orientalis*. A, an enlarged seed, the caulicle at the right. B, group of seeds, natural size. C, showing the white hairy appearance of the mucilage after drying.

inch long, and rather constant in size and form. They are light or dark brown, often reddish tinged, throughout, except the lighter scar at one extremity. The position of the caulicle is made evident by two distinct grooves lengthwise, the grooves indicating the cotyledons being indistinct or wanting. A small light colored membrane at the scar occupies a slight notch between the caulicle and cotyledons. The surface is comparatively coarsely granular and finely striated lengthwise. It is dull or has a slight diffused reflection under the lens. The cotyledons are uniformly incumbent. When placed in water, the seeds develop a dense coat of coarse radiating mucilaginous fibres, which, on drying, remain as a conspicuous white hairy covering over the seed coat—an interesting and instructive test for these seeds. Further, a single well developed seed gives a distinctly bitter taste.

Mr. Dewey states that these seeds are especially liable to occur with those of wheat, oats and flax from the Northwest. They probably would be found, also, with other grass seeds and the larger clover seeds from the same region.

Cleome lutea Hook., is the technical name of a coarse, yellow-flowered plant belonging to the Caper family. Its seeds are produced in narrow drooping pods terminating slender spreading stems. It is closely related to the commonly purple-flowered Rocky Mountain Bee-plant, *Cleome integrifolia* T. & G., of the Rocky Mountain region. The plant is not a formidable weed, but has become well established, often in dense patches, along the line of the Central Pacific railroad.

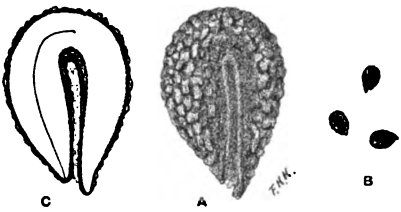

Fig. 21.

The *seeds* are rather acutely egg-shaped, also wedge-shaped in the direction of the two similar faces, being thinnest at the pointed extremity. They are approximately one-eighth of an inch long, but vary somewhat in size. Well matured seeds are brown or nearly black, or grayish mottled from the presence of light colored, inflated and papery projections from the outer seed coat which is otherwise finely

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Fig. 21.—*Cleome lutea* A, a side view of a seed, enlarged B, seeds, natural size C, a longitudinal section of a seed, showing the character of the embryo, the intrusion of the seed coats, and the thickened portion of the inner coat.

roughened and dull. These surface projections make most of the seeds very rough. From near the center of each face, a more or less distinct and margined groove extends toward the pointed extremity, terminating in a notch at one side of the same, at which point the scar is located. The embryo is bent at its center, the cotyledons resting incumbently to the caulicle, and separated from it by an intrusion of the seed coats corresponding to the external groove of each face. The inner seed coat separates readily from the outer coat on dissection. It is rather tough, yet thin, except at the inner curvature of the embryo where it is fleshy thickened, having the appearance of a deposit of endosperm. The embryo and inner coat are yellowish. No mucilage is produced in the presence of water.

Smooth, creamy yellow, sterile, yet full sized seeds occur frequently with the perfect ones.

Considering the size and habit of this plant, the seeds are scarcely to be expected among commercial seeds.

The PINK FAMILY, *Caryophyllaceæ*, contains a number of weeds of the farm and garden, whose seeds are widely distributed in commercial seed. Some of the plants are passive in character, while others, as Cow-herb, or Cockle and Corn Cockle, are most detrimental pests. The seeds of the following weeds of this family are more or less rounded or angular, the slender embryo curved to form a ring about the endosperm. These seeds do not develop mucilage in water.

CATCHFLY is the popular name applied to several plants of the genus *Silene*, which inhabit cultivated lands and grass and clover meadows. The name arises from the fact that most of the plants have a sticky hairy covering which holds the smaller insects alighting on it. The seeds of the several kinds of Catchfly are very similar, but differ somewhat in size, color and surface markings.

The NIGHT-FLOWERING CATCHFLY, *Silene noctiflora* L., has narrowly or broadly kidney-shaped *seeds* which vary from one-twentieth to one-sixteenth of an inch in length. They are flattened, rather thick, and have rounded or flattened edges. Each face is slightly depressed toward the concave edge, where its profile presents a small, rounded protuberance. The concave edge contains, between the two protuberances, a deep cavity indicating the position of the scar. The surface is roughened by numerous minute elevations or tubercles, which are more or less distinctly arranged in rows on, and parallel with, the edges. They become imperfect and indistinct about the scar. The grooves between the tubercles are narrow, distinct and comparatively deep. The compound microscope shows the sides of the tubercles to be toothed, the teeth of adjacent tubercles fitting, more or less perfectly, cog-wheel-like. The color is dull grayish brown, darker about the scar. Usually, each tubercle is tipped by a dark or black point. Small immature seeds are red or reddish tinged.

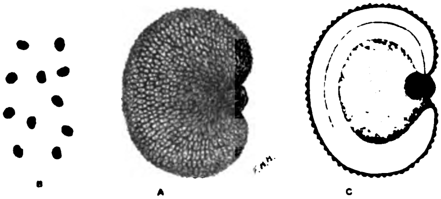

Fig. 22.

The Night-flowering Catchfly's habit of growth in meadows leads to the frequent occurrence of its seeds with grass and clover seeds.

The *seeds* of Sleepy Catchfly, *Silene antirrhina* L., differ from the preceding in being approximately one-thirty-second of an inch long, and having relatively coarser and more uniform tubercles whose lateral teeth are shown by the compound microscope to fit with beautiful precision. They are almost black.

Cow-herb, or Cockle, *Vaccaria vulgaris* Host, (*Saponaria Vaccaria* L.) is an annual plant becoming well known in the grain regions of the West. Prof. Aven Nelson stated in 1896 that this was the worst weed of Wyoming grain fields, especially those of spring wheat. Prof. C. S. Crandall reported in 1893 that the plant was so abundant in grain fields of Colorado as to rank among the worst weeds. It has, within recent years, come to have a like reputation in Manitoba, according to Prof. Jas. Fletcher, of Ottawa, Canada.

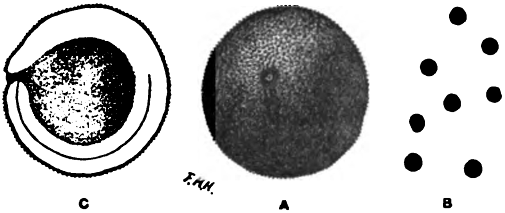

Fig. 23.

Fig. 22.—Night-flowering Catchfly, *Silene noctiflora*. A, a side view of a seed, enlarged, the "concave" edge at the right. B, group of seeds, natural size. C, section of seed showing the embryo curved about the endosperm.

Fig. 23.—Cow-herb, or Cockle. *Vaccaria vulgaris*. A, a seed, greatly enlarged, showing the scar and surface projections. B, a group showing the natural size. C, a section through the scar, showing the embryo encircling the endosperm.

The plant grows in Nevada and adjacent California to a serious extent, judging from the appearance of grain received at local flour mills. The plants stand one to two feet high, branch profusely above. and have light green herbage and rather large showy, pink, flowers.

The *seeds* are somewhat imperfectly spherical, but roll readily on a level surface. They are approximately one-twelfth of an inch in diameter, but vary somewhat in size. Mature seeds are jet-black and normally dull; immature ones red or reddish tinged. Occasional seeds glisten somewhat. The surface is finely roughened by a great number of minute projecting points. In one direction from the scar. these are rather distinctly arranged in rows. The usually light colored scar rests in a small depression in the surface, a slight projection of the latter at one side of the scar depression indicating the position of the tip of the caulicle of the embryo. The position of the slender embryo encircling the endosperm is often easily discernable in the fragments of the seeds which frequently occur with wheat and other grains.

The size of these seeds and the habit of their plants, rather preclude their appearance with other than the seeds of the grains. Screenings of grain received at local mills from the grain districts of northern California, shown the writer, contained these seeds to the extent of 50 or 75 per cent.

The nature of Cow-herb justifies the most careful attention to the removal of all its seeds from seed grain. It is claimed that this can be done easily by properly screening.

CORN COCKLE, *Agrostemma Githago* L., has long been a recognized pest in grain fields. It is injurious, both to the growing crop and the ripened product. The plant is an annual, closely related to Cow-herb, and has showy, rose-colored flowers. So far as is known. the plant does not occur as a pest in Nevada.

The *seeds* are somewhat angularly rounded in outline, and vary from one-twelfth to one-eighth of an inch in diameter. They are somewhat flattened, especially so on two similar faces; and, often more or less so on the broad edge, giving them a somewhat triangular outline. The faces are hollowed toward one edge, and nonparallel, making the seeds wedge-shaped, often acutely so. The thinner edge is notched and bears the usually inconspicuous scar. The color is dull jet-black; or, occasionally, the darkest shade of brown. The very rough surface consists of crowded, short ridges, teeth or spines. These are arranged in rows leading from the scar, which are most evident on the edges of the seed, though more or less eccentrically so on each face. About ten or twelve rows of spines occur on the edge. The spines and teeth of the edge diminish to minute ridges toward the depressed part of each face. Often, through severe compression during development, some of the spines are flattened, causing the seeds to become sharply angled.

The seeds of Corn Cockle are of very frequent occurrence with those of the various grains, particularly wheat, from which they are removed with difficulty. In some sections, their presence in wheat materially reduces its price. Flour from grain containing these seeds is discolored and its quality reduced. Furthermore, it is said that these seeds have a poisonous influence upon fowls and cattle.

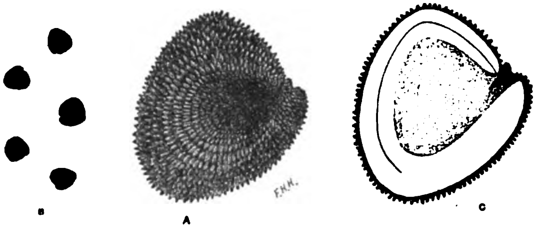

Fig. 24.

The CHICKWEEDS are very common little plants of eastern fields and roadsides, having white, star-shaped flowers. The two kinds whose seeds are commonest in commercial seed are *Alsine* (*Stellaria*) *media* L , and *Alsine graminea* Britton.

The *seeds* of these plants are very small, approximating one-twenty-fourth of an inch in diameter, though somewhat variable in this respect. Both are distinctly flattened. Those of COMMON CHICKWEED, *Alsine media*, are commonly circular, but often broadly egg-shaped or even wedge-shaped in outline. The similar faces are nearly parallel; the edge rounded or more commonly flattened, the seed being comparatively thick. A

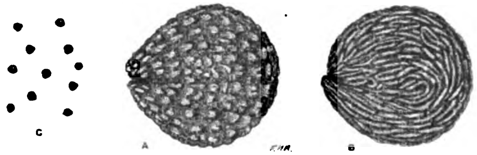

Fig. 25.

Fig. 24.—Corn Cockle, *Agrostemma Githago*. A, a seed, magnified, side view. B, group of seeds, natural size. C, a section through the scar, showing the embryo and endosperm.

Fig. 25.—Seeds of Chickweeds. A, *Alsine media*, enlarged. B, *Alsine graminea*, enlarged. C, group showing the natural size of the seeds of both species.

notch in the edge indicates the position of the scar. The surface is sparingly, or usually rather thickly and finely tubercled, the tubercles sometimes constituting mere points, rarely short ridges. These are sometimes disposed in curved rows on the faces, usually so on the edge. The surface is dull, and the color varies from reddish yellow to dark brown, those found with the commercial seeds usually having the latter color.

The *seeds* of *Alsine graminea* differ from those of *A. media*, in being more commonly nearly circular in outline, with the edge, and often the faces, more distinctly rounded. Instead of being tubercled, the surface is more or less thickly covered with fine, short and mostly curved ridges, which usually form broken rows along the edge. The color of these seeds, as found in commercial seeds, at least, is uniformly dull brown.

The seeds of both of these Chickweeds are often found with the smaller grass and clover seeds, and lawn mixtures. The smaller, more angular and lighter colored seeds of *A. media* are very similar to those of the following plant.

MOUSE-EAR CHICKWEED, *Cerastium vulgatum* L., (*C. triviale* Link), is a common plant of damp meadows, pastures and roadsides in the East, and is not greatly unlike the true Chickweeds. What is probably the same species, is common in like situations in Nevada. It is a branching plant, growing six to eighteen inches high, the small white flowers having sepals and petals of equal length. The herbage is finely sticky hairy, and the thin, tubular, projecting, fruiting capsules open at the toothed apex. It is not an aggressive weed, but the frequent appearance of its seeds with commercial seeds justifies their description.

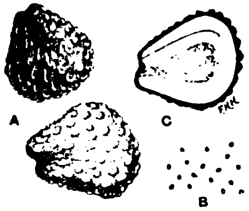

Fig. 26.

The *seeds* of Mouse-ear Chickweed are minute, varying from one-forty-eighth to one-thirty-second of an inch across. They are angular in form with more or less rounded corners, and sufficiently flattened to commonly rest on one of the two similar faces. The scar is located in a notch in the narrower, thinner edge. The surface is dull, and roughened by small,

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Fig 26.—Mouse-ear Chickweed, *Cerastium vulgatum*. A, two prevailing forms of seeds, side view. B, a group, natural size. C, a section between the faces, showing the embryo and endosperm.

rather irregularly placed tubercles or short ridges. On the thicker, flattened, or even slightly grooved, edges, they are evidently arranged in rows. The color varies from light reddish yellow to dark reddish brown, usually darkest about the scar. The embryo forms a nearly complete ring about the endosperm.

These seeds are one of the commonest of kinds found among the smaller grass and clover seeds. Their small size, angular form and light color should readily lead to their recognition. It is probable that the seeds of closely related species of *Cerastium* are very similar to these. Occasional seeds are sufficiently rounded to lose the usual wedge-shaped profile, when they may have much the appearance of small seeds of *Alsine media.*

CORN SPURREY, *Spergula arvensis* L., known also as Spurry, is a very common, but not especially harmful, little weed of the eastern States. It is a plant of the Old World, which has become widely distributed in commercial seeds.

The *seeds* are very small or minute, varying from one-twenty-fourth to one-sixteenth of an inch in diameter. They are circular in outline, and usually very convexly lens-shaped in section. The color is dull jet-black except the sharply acute or narrowly winged margin, which is yellowish, or sometimes whitish. The margin is commonly broadly notched at the scar The surface is finely roughened; and often, in addition, sparingly or densely sprinkled with whitish, yellowish or even black projecting particles. On a level surface, the seeds roll somewhat readily; and, rest upon the center of one face, or on the edge of one face exposing a part of both. The embryo is slender, cylindrical, and spirally coiled within the endosperm.

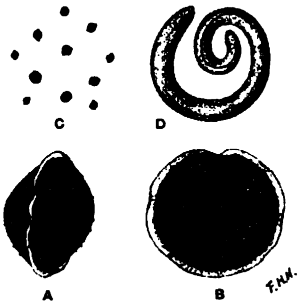

Fig. 27.

The seeds of Corn Spurrey are frequent intruders in the smaller grass and clover seeds and the lawn mixtures.

The *seeds* of another Old World Spurrey, probably *Spergula pentandra* L., are sometimes found with commercial seeds. These

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Fig. 27.—Corn Spurrey, *Spergula arvensis*. A, an edge, and B, a side view of a seed, enlarged; the scar in the upper margin of B. C, a group showing the natural size. D, the spirally coiled embryo.

are very similar to those of Corn Spurrey in their general form. The conspicuous difference in appearance is in the broader, marginal wing which is about half as wide as the body of the seed. These seeds, too, are jet-black; the wing brown with radiating stripes, lightest at its usually more or less ragged edge. The scar is at the base of a narrow cleft in the wing. The whitish surface particles are finer than those of *S. arvensis*, and are collected in a zone just within the wing. The slender, cylindrical embryo is curved, forming a nearly complete ring, in which respect it differs from the spirally coiled embryo of *Spergula arvensis.*

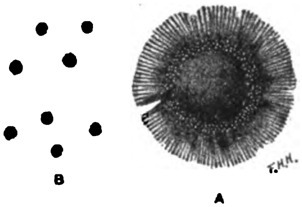

Fig. 28.

These seeds are much likened to those of Yellow Toad Flax, *Linaria Linaria*, but differ in their kernel structure and circular form.

The COMMON PURSLANE, or PUSLEY, *Portulaca oleracea* L., is a prostrate plant having smooth, green or purple-tinged, fleshy herbage. Its small, inconspicuous, yellow flowers open in early morning. It is distinctly a weed of gardens and cultivated fields; and, as such, is known everywhere.

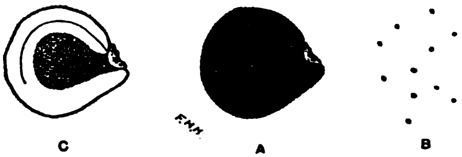

Fig. 29.

The *seeds* are jet-black and minute, yet vary in size from one-fortieth to one-twenty-fourth of an inch in diameter. They are flattened and broadly egg-shaped, a notch at one side of the smaller extremity bearing the relatively conspicuous, whitish scar. The edges are rounded, and the faces are slightly depressed to a short groove on each face leading to the scar. The surface is finely roughened, the almost microscopic elevations forming faint, radiating ridges which are, in turn, faintly disposed in two or three concentric rows. A slight reflection of light from the ridges is evident under the lens.

These seeds are further like those of the Pink family in having the

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Fig. 28.—*Spergula pentandra* L. (?) A, an enlarged side view of a seed, the scar-cleft at the left. B, a group showing the natural size.

Fig. 29.—Purslane, *Portulaca oleracea*. A, a side view of a seed, enlarged, showing the whitish scar. B, a group, natural size. C, section of a seed, taken parallel with the faces.

embryo curved to form an almost complete ring about the small endosperm.

The habits of growth of Purslane would seem to prevent its seeds from becoming mixed with the various field seeds. However, in Bulletin No. 70, 1890, N. C. Agricultural Experiment Station, Prof. Gerald McCarthy says of them: "The seeds of this plant are nearly always present in the grass and clover seeds sold by cheap dealers."

The COMMON MALLOW, or "CHEESES," *Malva rotundifolia* L., is a low, spreading, tough-rooted plant of lawns, roadsides and fields, everywhere. It has round or kidney-shaped leaves on slender leaf-stalks, and white, rose-colored or bluish flowers. The flat, circular fruits, often called "cheeses," have the single-seeded cells (carpels) of the flower pistil arranged in a circle about a broad, flat, central axis.

The *seeds* approximate one-sixteenth of an inch in diameter, but are apt to vary somewhat in size. The outline is rather constantly circular-kidney-shaped, one edge presenting a deep notch and an adjacent, distinct protuberance. The seeds are much flattened, the non-parallel, slightly concave faces sloping to the notched edge. Thus they are somewhat wedge-shaped in the direction of the faces. The margin is uniformly rounded. The notch may be empty, but more commonly is nearly filled by the scar tissue. The outer seed coat is thick and hard. The surface is smooth or very finely roughened, and dull. The color is light reddish brown, gray or very dark brown, often lighter about the notch, due to the presence of mealy particles of the seed vessel. Often, the greater part of the seed vessel, or carpel, persists since it does not have a regular mode of opening for the discharge of the ripened seed. The carpel wall is thin and dull, and varies from a light to a dark color. Its flattened faces, corresponding to those of the seed, are sharply margined and often present a few radiating ridges. Furthermore, the rounded edge is faintly reticulate-ridged. The embryo is curved, a small quantity of

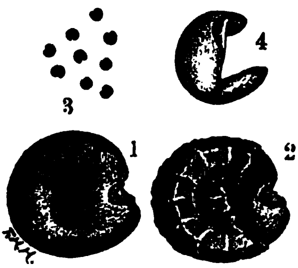

Fig 30.

Fig. 30.—Common Mallow, *Malva rotundifolia*. 1, a seed, magnified, side view. 2, the same, partially enveloped by the persistent seed vessel. 3, group showing the seeds, natural size. 4, the embryo, removed from the seed coats, a side view somewhat reduced from the magnification of 1 and 2.

endosperm lying between it and the notch of the seed. The tip of the caulicle lies in the marginal protuberance. The cotyledons are leaf-like and folded lengthwise; from which fact the form of the embryo is best discerned by its complete removal from the seed coats. Shortly before the maturity of the seed, the embryo constitutes a very small, straight, bright green body having minute, flat cotyledons, and lying within the marginal protuberance. The color is lost with further development.

These seeds are occasionally reported as occurring with commercial seeds, but they are much less common than many others.

Alfilaria, *Erodium cicutarium* (L.) L'Her., known also by the common names Filaree, Stork's-bill, Pin-grass and its Spanish name, Alfilerilla, is recognized as one of our best wild forage plants. It has, however, been considered as a weed by some writers, probably owing to the fact that the ripened seed vessels cling to the wool of sheep, and even pierce the skin, for which they are admirably adapted. The plant is very common in western Nevada, growing wherever sheep have ranged. Stockmen assert that the plants spread by the carrying of the seeds in wool. On dry land, the plants form rosettes of leaves and short stems close to the ground. In damp places, they are larger, producing spreading stems and an abundance of leaves. The deep pink flowers open mostly in the forenoon.

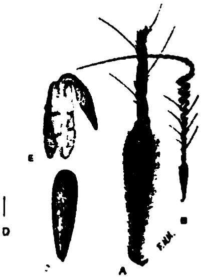

Fig. 31.

The *seeds* are distributed chiefly as fruits, each consisting of a lance-shaped seed vessel having a curved tip of needle-like sharpness, and bearing a long awn. The awn is spirally coiled for half its length above the seed vessel, the remaining portion projecting to one side of the coil and curved in sickle-like form. The average seed vessel is approximately three-sixteenths of an inch long, the awn about one and one-fourth inches in length when straightened. The seed vessel is roughened and dull, and thickly covered with fine, appressed hairs which are "parted," as it were, at one

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Fig. 31.—Alfilaria, *Erodium cicutarium*. A, a seed vessel with a portion of its spirally coiled awn. B, a seed vessel and its awn, natural size. (In many, the awn is smaller.) C, a seed, magnified. D, a line showing the length of the seed. E, the embryo removed from the seed coats, the parts spread.

(the back) of the sutures, or seams of the seed vessel. The hairs become thicker and longer toward the tip from which projects a small tuft of them. On each of two opposite sides of the apex of the seed vessel is a characteristic, smooth, circular, concave and margined area. The awn is thinly covered with fine appressed hairs, a few much longer bristles projecting from the lower two-thirds of the spiral. The color of the the seed vessel and awn is dark reddish brown; the hairs of the former being yellowish brown, those of the latter, whitish.

Threshing frequently breaks the seed vessels, disclosing or expelling the smooth, dull, brown, broadly club-shaped seeds. They are nearly one-eighth of an inch in length. The scar is situated on one side near the smaller extremity which is terminated by a projecting point (the chalaza), the latter connected with the scar by a slender ridge (the raphe). The seeds are without endosperm. The embryo is bent upon itself, the caulicle rather accumbently placed, and the leaf-like cotyledons compactly folded lengthwise.

The seeds of Alfilaria are very apt to occur with commercial seeds of western production Indeed, they have been found with such seeds received from California.

Several kinds of CRANE'S-BILL, *Geranium*, grow in fields, along roadsides and in waste places. They are not very pernicious plants anywhere; and, so far as the writer knows, are not to be classed among the weeds of Nevada.

The *seeds* of one kind, at least, of *Geranium* are often found among the coarser grass seeds. They vary from one-sixteenth to one-twelfth of an inch in length and are oblong in outline, or have the extremity bearing the scar somewhat broader than the other. They are not flattened and roll readily. The surface is finely pitted, the intervening spaces forming a whitish or soiled-brown network. Sometimes some of the pits are in distinct rows, but usually they are irregularly placed. The network is readily rubbed away; so frequently the surface of these seeds

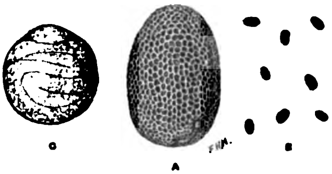

Fig. 32.

Fig. 32.—Crane's-bill, *Geranium*. A, an enlarged view of a seed, showing the rather characteristic surface network, the scar and adjacent ridge. B, a group showing the natural size of the seeds. C, a cross section of a seed, showing the relative positions of the parts of the embryo.

found among commercial seeds is nearly or quite smooth with only a faint indication of the former network. Such seeds are dark reddish brown in color, and often have a slight diffused luster under the lens. The scar is near one extremity, often terminating a slight, longitudinal protuberance of the surface indicating the caulicle. A short ridge leads from the scar to a similar spot (the chalaza) at the adjacent extremity. The seed is without endosperm, the embryo compactly folded and closely fitting the seed coats, the outer one of which is hard and unyielding. The caulicle is incumbently placed against one of the cotyledons, both of which are twice folded lengthwise, one broad fold of each including the closely folded half of the other.

These seeds might be confounded with the somewhat similar-appearing ones of *Brassica nigra*, and perhaps other species of *Brassica*. The character of the surface markings and the embryo should serve to distinguish them, however.

White Sweet Clover, *Melilotus alba* Desv., known also as White Melilot and Bokhara Clover, has the double reputation of a forage plant and a weed. Its value as a forage plant may be only conditional; and, it is probably a weed only when permitted as such. It is a very common plant in Nevada, lining irrigation ditches almost everywhere. Its sweet odor gives rise to one of its popular names.

The *seeds* of White Melilot, while resembling those of red clover and alfalfa in some respects, are more strictly elliptical-oblong in outline, barring the broad, shallow notch near one extremity and including the scar. They approximate one-twelfth of an inch in length and are somewhat flattened. The surface is smooth and dull. The color is commonly yellowish or greenish. A usually evident lighter stripe and shallow depression on each face leading from the scar indicates the position of the caulicle. The cotyledons are accumbent and the seeds are without endosperm.

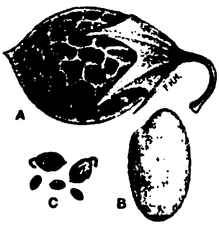

Fig. 33.

The *pods* which often occur with commercial seeds are more evidently characteristic of the species. They are about one-eighth of an inch long and somewhat flattened; also, rather unsymmetrically oval in outline, the lower edge usually being more convex than the upper or back edge. The tip is often short-beaked by

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Fig. 33.—White Melilot, *Melilotus alba*. A, a side view of a pod, enlarged. B, the same of a seed. C, a group of pods and seeds, natural size.

the persistent base of the flower style. The papery, funnel-shaped, toothed calyx often remains; also the slender, curved, flower stem. Furthermore, a part of the whitish, film-like stamen tube may project from beneath the calyx. The surface of the pod proper is quite characteristically, coarsely and irregularly reticulate-ridged, or wrinkled, a few ridges joining the lower marginal ridge with the surface wrinkles. The double ridge along the upper edge of the pod usually splits, exposing the single seed within. The color varies from straw-color to dark brown, or is green. The calyx usually remains lightest.

The seeds of this plant are often listed among the forage plants by seedsmen; and, they frequently occur in seed supposed to be pure, when the pods, at least, should be readily recognized, if present.

The *seeds* of YELLOW SWEET CLOVER, or Yellow Melilot, *Melilotus officinalis* (L.) Lam., are practically indistinguishable from those of White Sweet Clover. The *pods* of this species, as compared with those of the other, are slightly longer and slenderer, and the surface wrinkles are more evidently transversely disposed. Furthermore, the pod proper is somewhat slenderly narrowed at the base, resulting in a slight, but evident, constriction of the narrower calyx, chiefly at the back; and the persistent base of the style is often more beak-like.

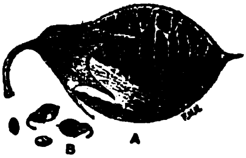

Fig. 34.

The seeds and pods of Yellow Melilot are doubtless less common among commercial seeds than those of White Melilot. The pods of either species occurring with such seeds are apt to be devoid of the calyx and stem, but it should not be difficult to recognize them by their form and surface wrinkles.

BLACK MEDICK, or NONESUCH, *Medicago lupulina* L., which is closely related to alfalfa, *Medicago sativa* L., is doubtless much better known as a forage plant than a weed, particularly in Europe. Other and better plants have replaced it in this country, yet it finds a place in lawns, fields and waste places, generally. It is low and clover-like, with small clusters of yellow flowers.

The *seeds* of Black Medick are similar to those of alfalfa in general

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Fig. 34.—Yellow Melilot, *Melilotus officinalis*. A, a side view of a pod, showing a portion of the persistent, thin, white stamen tube, enlarged. B, a group of seeds and pods, natural size. (See B, Fig. 33, for the form of the seed.)

appearance, but differ in being more commonly egg-shaped than kidney-shaped in outline. Occasional seeds are slightly kidney-shaped, but they are more uniform in shape than the seeds of alfalfa, since they are developed, a single seed in a pod. The scar is nearer the small extremity in these seeds than in those of alfalfa. A notch at the scar and the slightly projecting tip of the caulicle is usually evident. They are flattened and are approximately one-twelfth of an inch in length. The color is yellowish, reddish or greenish; the surface smooth and dull. Like the other clovers, the seeds are without endosperm, and the cotyledons are accumbent.

The *pods* are very characteristic of the species, though varying in size from one-twelfth to one eighth of an inch in length. They are much flattened with rather acute edge. The outline is oval or kidney-shaped, the result of being spirally coiled causing the two extremities to nearly meet. The acutely pointed tip indicates the spiral nature of the coil and is uniformly situated on the same side of the pod, (shown in the accompanying figure). The slender-pointed base of the pod often bears the somewhat persistent, whitish, white-hairy, slender-toothed calyx, which commonly exhibits two teeth on the side of the pod bearing the coiled tip, and three on the other side. The surface is not wrinkled, but comparatively smooth aside from the rather uniform, characteristic system of slender ridges exhibited by each face. These originate at the base of the pod; and, following its curvature, branch and reunite, and finally terminate in the marginal ridge. The color is commonly black, but frequent individuals are brown, very light colored or greenish. All are dull, and mostly free from the hairy covering possessed during development.

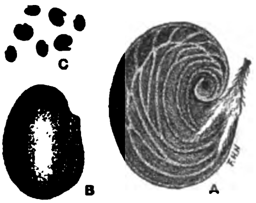

Fig. 35.

The seeds of Black Medick are very apt to occur with the seeds of the clovers, including alfalfa. The pods seem to be most frequently mixed with the larger grass seeds.

Several kinds of Cinquefoil, or Five-finger, *Potentilla*, grow in meadows and similar situations. They are said to readily appropriate weakened meadows in the East.

Fig. 35.—Black Medick, *Medicago lupulina*. A, a side view of a pod, enlarged. B, an enlarged view of a seed. C, seeds and pods, natural size.

The "*seeds*" of *Potentilla* are true akenes. Those of one kind are very common in white clover seed and the smaller grass seeds. They are minute and flattened, and approximately only one-twenty-fourth of an inch in length. In outline, they are rather unsymmetrically egg-shaped or kidney-shaped, one end being more broadly rounded than the other. They are somewhat lens-shaped in section. The surface bears a few curved ridges lengthwise, the central, longer ones branching somewhat. There is some variation in the arrangement and number of the ridges, and sometimes they are very obscure. The two faces are essentially alike. The color is light brown or straw-color, and dull. A cross section discloses the single, purplish seed within.

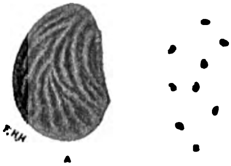

Fig. 36.

The writer has found these seeds commonest among the seeds of timothy and red-top.

The most conspicuous weed of the PRIMROSE FAMILY is the EVENING PRIMROSE, *Œnothera biennis* L., which in its wild state is considered a weed everywhere. It grows in meadows, pastures and along roadsides, usually preferring damp situations. Its large yellow flowers opening in morning and evening make it a plant well known to nearly everyone.

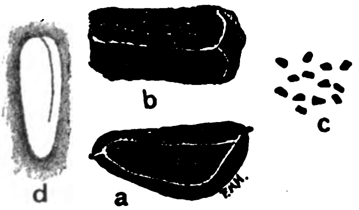

Fig. 37.

The *seeds* are approximately one-sixteenth of an inch in length, but vary somewhat both in size and form. Owing to severe compression during development, they are distinctly angled, the angles acute or more commonly narrowly winged. Most of them are either prismatic (B, Fig. 37) or four-sided with one face rounded (A, Fig. 37). Occasional specimens are pyramidal, others smaller and variously angled. The surface is finely roughened and usually faintly ridged lengthwise or somewhat obliquely. The indistinct scar is at one ex-

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Fig. 36.—Cinquefoil, *Potentilla*. A, a side view of an akene, enlarged. B, a group, natural size.

Fig. 37.—Evening Primrose, *Œnothera biennis*. A and B, the two prevailing forms of seeds, enlarged. C, a group showing the natural size. D, the embryo.

tremity. The color is quite uniformly dull, reddish brown, some seeds being faintly dark-mottled. There is no endosperm, the straight embryo completely filling the seed coats.

The seeds are of frequent occurrence with the various clover and grass seeds.

Two kinds of WILLOW-HERB, *Epilobium*, also weeds of the Primrose family, are common in Nevada. One of them, *Epilobium paniculatum* Nutt., has been called Cotton-weed on the Pacific Coast, where it is common. It is an upright, branching, summer plant of cultivated and neglected places. It has small, pink flowers which are followed by slender seed capsules, which set free, later, a great number of cottony-plumed seeds.

The *seeds* are very small, approximating one-sixteenth of an inch in length. They are flattened, and are acutely egg-shaped, or narrowly so. The smaller extremity is narrowed by a constriction about one-third of the length of the seed from this extremity. The two faces are slightly dissimilar, one (the outer in the seed vessel) rounded and variously dented or grooved: the other roughened or having a longitudinal depression containing a slender, central ridge. The seed-scar is at the smaller extremity of this face, a minute projecting scar at the broad extremity indicating the point where a tuft of fibres (the coma) was attached when the seed was expelled from the seed vessel. The surface is very finely granular and dull, or glistens slightly in some instances. The color is brown or steel-gray, the surface usually coarsely dark-mottled. The seeds are without endosperm, the straight embryo having broad, flattened cotyledons, its short caulicle resting in the pointed extremity of the seed.

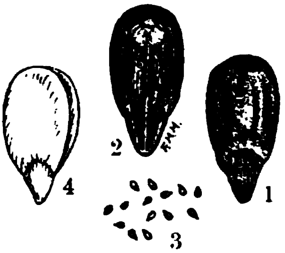

Fig. 38.

These seeds are probably not common in commercial seeds, yet they are subject to distribution by this means.

Epilobium adenocaulon Haussk., another kind of Willow-herb, is very common along Nevada irrigation ditches and in damp meadows.

Fig. 38.—Willow-herb, Cotton-weed, ***Epilobium paniculatum*.** 1, an outer-side, and 2, an inner-side view of a seed, enlarged. 3, a group showing the natural size of the seeds. 4, the embryo.

Its minute *seeds* are about one-twenty-fourth of an inch in length. They are rather spindle-shaped with a slight rounded appendage-like projection at the broader extremity. The color is dull, grayish brown, the surface very finely marked lengthwise by whitish, roughened ridges. Like the preceding, one face is hollowed or grooved lengthwise, and has a slender, central ridge, the two scars similarly placed. Its embryo is essentially the same as that of the preceding plant.

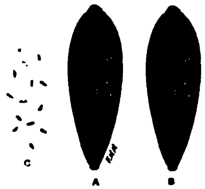

Fig. 39.

These seeds are not likely to be found with other than the smallest grass seeds.

The PARSLEY FAMILY, *Umbelliferæ*, has for its weedy representatives in Nevada, the widely distributed Wild Carrot, Wild Parsnip and Cowbane, or Poison Parsnip, as it is best known locally in western Nevada, at least. The general aspect and biennial character of these plants are pretty generally known. The fruits split at maturity forming two similar halves (carpels), each enclosing permanently a single seed. The carpels are longitudinally ridged and contain within their walls canals of aromatic oil, the "oil-tubes" The distribution of the seeds thus results from the transportation of these half-fruits, for which purpose they are variously adapted. The embryo is small and situated at one extremity of the endosperm which constitutes the greater part of the kernel.

WILD CARROT, *Daucus Carota*, L., in the original form from which the garden carrot has been developed, is becoming a serious pest in many parts of the United States, particularly in the East. In some places it is ranked among the worst of weeds. Meadows, pastures, roadsides and fence-corners it finds congenial to its existence. Its general likeness to the cultivated carrot in its deep, fleshy root, finely divided leaves and contracted, spiny, fruit clusters serves to identify this species. It occurs in Nevada, but as yet, not to the serious extent that it does elsewhere.

The *seeds* (carpels) consist, each, of a much flattened and thin seed-bearing portion of the fruit having an elliptical-oblong form and approximately one-eighth of an inch in length, from which project

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Fig. 39 —Willow-herb, ***Epilobium adenocaulon***. A and B, enlarged views of two sides of a seed. C, a group of seeds, natural size.

numerous spines. The spines, which in length approximate the width of the seed-bearing portion, fringe the margins of the latter, and also form a double row along one (the outer) face. The number and form of the spines vary somewhat, but each is tipped by a minute barb. Their color is whitish or yellowish, lighter than the dull brown of the carpel. They are frail, bending easily before drying and breaking readily afterward. Three narrow ridges bearing a few bristles alternate with the rows of spines, and three slender longitudinal ridges are usually evident on the flat, inner face of the carpel. One of the two flower styles often persists at the apex of the seed vessel. The oil-tubes are situated, one under each row of spines and two between the ridges of the inner face. The small embryo is situated at one extremity of the abundant endosperm.

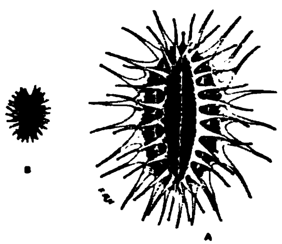

Fig. 40.

Fig. 40.—Wild Carrot, *Daucus Carota*. A, an outer-side view of a seed, or carpel, enlarged. B, one showing the natural size.

The distribution of these seeds is greatly assisted by the barbed spines which permit them to cling to passing objects. They are often retained in the contracted fruit clusters until the winds of winter scatter them far and near over the snow. One author states that these seeds are distributed with grass and clover seeds.

WILD PARSNIP, *Pastinaca sativa* L., is a degenerate form of the garden Parsnip which has escaped from cultivation and run wild almost everywhere. In western Nevada, as elsewhere, large patches of this plant may be found in damp places along roadsides and in fields. The appearance of the wild plants is similar to that of the cultivated forms. They may be distinguished from what is often called Poison Parsnip by their coarse, deeply grooved stems and broad, flat clusters of small, yellow flowers.

Poisonous properties have been attributed to this plant by many writers, but the observations recorded by Prof. L. H. Pammel in Bulletin No. 28, 1895, of the Iowa Agricultural Experiment Station, would overthrow this popular supposition. It is probable that the cases of poisoning supposed to be due to this plant are to be properly charged to the Spotted Cowbane, which is next considered.

The *seeds* (carpels) of Wild Parsnip are very thin and nearly circular or broadly elliptical-oblong. They average nearly a quarter of an inch in diameter, but are variable in this respect. At the apex, the margin is notched containing the persistent, thickened base of the flower styles. The color is light to dark brown and dull, the narrow, wing-like margin lighter. The two faces differ in that the outer face is convex and beveled at the margin. Three narrow ridges run lengthwise across this face, fading at the base. Four oil-tubes alternating with the ridges extend from the apex nearly across the face. They are indicated by their darker color. The inner face is concave and has a central, longitudinal ridge with a broad oil-tube on each side. A forked remnant of the carpophore, a part of the flower receptacle, is usually present upon the central ridge at the apex. This face is often darker than the other.

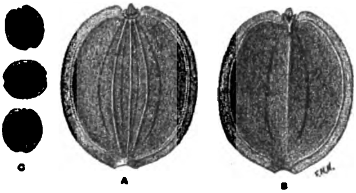

Fig. 41.

The seeds resemble those of the cultivated parsnip sufficiently to be practically indistinguishable from them. They are readily transported by the wind and irrigation water, but are not apt to occur with commercial seeds.

Poison Parsnip is the name by which *Cicuta maculata* L., is best known in western Nevada and in some other parts of the country. That this plant's noxious character is widely known is evident in the many popular names which it bears. These include the following: Cowbane, Spotted Cowbane, Water Hemlock, Poison Hemlock, Beaver Poison, False Parsnip, False Parsley and Poison Parsnip. The deadly poisonous nature of this plant, affecting man and beast alike, should be known by all. The plant occurs in damp places and thus is found on the roadside, along fences and in meadows, particularly along the margins of irrigation ditches. Its coarse, hollow, cylindrical stems stand from two to five feet in height. In the East, the stems are purplish spotted or streaked, a character not always evident in Nevada specimens. The leaf-like leaflets form large, bi-compound leaves, the individuality of which is evident in the single, strong leaf-stalk. The stems branch above, bearing at first rounded clusters of small, white

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Fig. 41.—Wild Parsnip, *Pastinaca sativa*. A, an outer-side view, and B, an inner-side view of a seed, or carpel, enlarged. C, carpels, natural size.

flowers. Later, these clusters become more or less open-spherical in form, the flowers being replaced by the small, hard fruits each containing two seeds. The root is biennial, fleshy and creamy white when fresh. It usually branches near the apex into several more or less equal parts, each tapering and sometimes attaining the size of one's finger. The sweetish taste the roots are said to have only increases the danger from their poisonous properties, data upon which has been published by Prof. L H. Pammel in Bulletin No. 28, 1895, of the Iowa Agricultural Experiment Station. The distinguishing features of this plant as compared with Wild Parsnip are found in its branching root, cylindrical stems, bi-compound leaves, white flowers and the smaller, somewhat spherical, rather than large, flat, fruit clusters.

The *seeds* are often represented by the entire fruit, the two carpels being held together by the thin, membranous epidermis, or outer skin. As such, the fruit is somewhat flattened, rounded, rather imperfectly circular, and about one-eighth of an inch in diameter. The surface may be merely roughened or distinctly and coarsely five-ribbed on each carpel. When the carpels separate, the flattened, inner face usually exhibits a groove through the center. The ribs, or ridges, are rounded, the narrow, alternating grooves darkened by the presence of the oil-tubes, of which two others occur on the inner face. The distinctness of the ribs and grooves is due to the close-fitting of the thin, outer skin of the fruit. The surface is dull and green or brown, often tinged with purple.

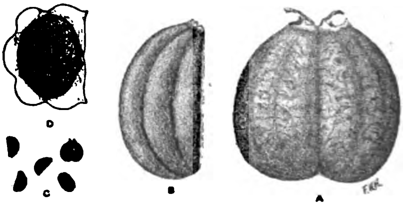

Fig. 42.

Owing to the habit of this plant to grow along the edges of irrigation ditches, the seeds cannot fail to be widely distributed by running water. It is not impossible for them to occur with grass seed; however, it is not probable that they are disseminated to any great extent in this way.

Fig. 42.—Poison Parsnip, or Cowbane, *Cicuta maculata*. A, a whole fruit of two carpels, the loosely fitting outer skin nearly obscuring the ribs of the carpels, much enlarged. B, a side view of a single carpel, or "seed," showing the ribs distinctly. C, a group showing the natural size. D, a cross section of a carpel, showing the abundant endosperm, and the relative positions of oil-tubes and ribs.

FIELD MADDER, *Sherardia arvensis* L., is a small annual plant from the Old World, to the seeds of which our attention is drawn by the frequency with which they are found with commercial seeds.

The *seeds* (half-fruits, or carpels), as occurring with commercial seeds, usually consist of oblong or oval bodies terminated at one extremity by three marginal teeth or lance-shaped awns. They vary in length from one-twelfth to two-twelfths of an inch, including the teeth. The dull, brown color of the body of the "seed" is more or less speckled by short, slender, hair-like-appearing, whitish or tawny particles lying lengthwise and slightly elevated from the surface. The whitish or yellowish awns and portion of the body immediately beneath may be somewhat whitish bristle-hairy, or smooth. The larger awns are often membranous-connected, making the extremity somewhat cup-shaped. The body of the fruit is rounded and slightly flattened. One side (the inner) has a central, longitudinal groove which leads to the fruit scar at the extremity opposite the awns.

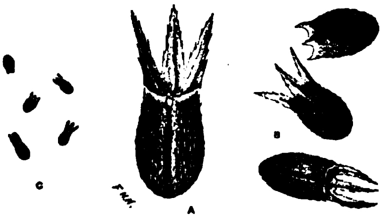

Fig. 43.

The teeth, or awns, form a part of the persistent, flower calyx which closely invests the carpel proper. Its thin wall contains the surface particles which the compound microscope discloses to be large, thick-walled cells, each containing a multitude of needle-like crystals (raphides). Often the calyx teeth are broken away, leaving only the form and surface markings to indicate the seeds' identity. After prolonged boiling, the calyx wall can easily be removed, disclosing the carpel proper which, in appearance, is much likened to a coffee-bean, to which it is closely related. The carpel wall adheres closely to the seed proper, which has an abundant, hard endosperm. The slightly curved embryo has thin, egg-shaped cotyledons and a slender caulicle. It has an upright position in the center of the seed, surrounded by the endosperm.

The writer has often found these seeds associated with the coarser grass seeds, particularly those of the rye-grasses.

Fig. 43.—Field Madder, *Sherardia arvensis*. A, an enlarged view of the inner side of a seed (half-fruit). B, a group showing the common variation in form and awns. C, a group showing the natural size.

The COMPOSITE FAMILY, *Compositæ*, is that which contains the Sunflower. Dandelion and Daisy. It is the largest of the natural orders of flowering plants, and includes a number of our worst weeds. A prominent character common to the plants of the family is the occurrence of their individual flowers in compact clusters, or "heads" (with a few exceptions), which have the appearance of single flowers.

The "*seeds*" of the Compositæ are true, single-seeded fruits called *akenes*. They vary much in form and markings in different plants, sometimes even in those which are closely related. In some instances, there is an evident difference in the form of the akenes developed in the same cluster, in which the central ones are narrower and straighter, and often longer than the outermost ones. Thus may the difference in form of otherwise similar seeds of this family be accounted for. The akenes commonly agree in having an evidently greater length than width, and most of them present a more or less evident scar at each extremity. Neither of these scars is a true hilum, however. That at the usually smaller extremity, the base, marks the point of separation of the akene from the receptacle of the flower cluster. The scar at the apex results from the falling away of the corolla and style of the individual flower to which the akene belonged, and is often represented by a projecting particle, or appendage. This extremity of the akene is in most, but not all, species provided, at maturity, with a tuft of fibres or crown of scales, the pappus. (See Distribution of Weed Seeds, p. 7.) In most cases, there is no distinct evidence of the former presence of the pappus, but in some, it remains, either wholly or in part. The akenes of Ox-eye Daisy, Burdock, the Sow Thistles, Chicory and Orange Hawk-weed illustrate these several forms. Some akenes show no evidence of a true scar at the apex owing to the possession, at maturity, of a slender elongation of the akene (the beak), which bore the other organs of the flower, and which readily breaks away at its base after drying. The akenes of Dandelion and Prickly Lettuce illustrate those possessing a beak. The single seed of the akene has thin seed coats of no value in classification, and is without endosperm. The embryo is straight and upright, and assumes the general form of the akene. In some instances, the akenes, even, lose their identity in the united and hardened bracts of the persistent involucre of the flower cluster, as in the Clot-burs and their allies.

GUM-WEED, ROSIN-WEED, *Grindelia squarrosa* (Pursh) Dunal, is known in the South as Asthma-weed and Wax-weed. It is a perennial or biennial plant which in some places in the West is becoming a bad pest. Prof. Charles S. Crandall writes of it in Bulletin No. 23, 1893, of the Colorado Agricultural Experiment Station, as follows: "This species is very common in all territory west of the Mississippi; it is extending eastward, and has been reported from Minnesota, Iowa, Missouri and Illinois. Here [Colorado] it is most conspicuous along roadsides and on plains that have been broken up and then neglected; it invades cultivated land, and locally is very troublesome in corn-fields. The sum of its pestiferous and undesirable qualities warrants giving it a place among our worst weeds."

It is reported from Manitoba as "rapidly spreading into fields and upland meadows."

The plant is not generally distributed in western Nevada. In one locality in Reno, however, it has persisted and spread for several years. The plants stand one to two feet high with several stems from the ground. The leaves are stiffish and toothed. The upper branches are tipped with round heads which, until the bright yellow flowers appear, are covered with a whitish, resinous gum.

The *seeds* (akenes) of Gum-weed vary exceedingly in size and form. Most of them are between one-twelfth and one-eighth of an inch in length. They usually agree in being more or less flattened and faintly, or sometimes plainly four-angled. Straight and distinctly curved specimens are equally common. They are all narrowed at the base where the small, white scar is evident, but not prominent. The apex is truncate, obliquely so in the curved specimens, a projecting particle representing the scar. This extremity is often concave with a distinct marginal rim, which fact, combined with the general form, makes some of these akenes not greatly unlike those of Canada Thistle. The surface characters are variable also. Some akenes are smooth; others are finely grooved, ridged or striate lengthwise; still others are somewhat wrinkled, particularly at the angles, which are then somewhat "corky-thickened."

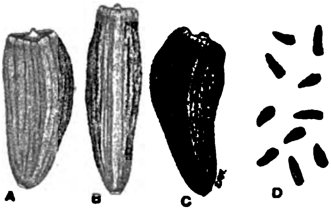

Fig. 44.

Fig. 44.—Gum-weed, *Grindelia squarrosa*. A, B, C, three common forms of seeds (akenes). B, one produced near the center of the flower cluster. D, a group showing the variation in size and form.

The surface is normally dull, but sometimes glistens under the lens owing to its being varnished with the glutinous secretion so conspicuous on the immature flower clusters. The color of the akenes is creamy-white or light brown; or, they are sometimes almost pure white. The presence of the glutinous secretion often causes the akenes to stick together.

While these seeds are not now a common ingredient of commercial seeds, they are very apt to become so as the plants become more common in seed producing regions.

HORSE-WEED, BUTTER-WEED, Mare's-tail, Fire-weed and Fleabane are the several popular names by which *Erigeron Canadensis* L. is generally known. The plant is said to be a native of America which has spread over Europe in partial payment for the many contributions of its kind received from there by this country. It is an erect annual plant having many erect or recurved, narrow leaves, the main stem and branches terminated by close clusters of flower-heads. These ripen a multitude of seeds which are scattered far and near by the wind, each buoyed by its rather persistent, fragile pappus. Seed-producing plants occur in all sizes up to six or seven feet in height. Moist ground is preferable and roadsides, meadows, pastures and fields generally are invaded. It is a common plant in Nevada.

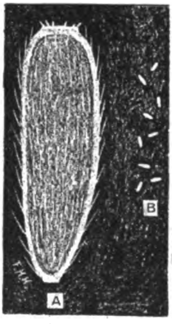

Fig. 45.

The *seeds* (akenes) are minute and insignificant, having little to characterize them. They are approximately one-twenty-fourth of an inch in length, oblong-lance-shaped in outline, much flattened, often with one edge somewhat more convex than the other. The narrowly margined edges are often lighter than the dull, cream color of the rest of the akene. The minute, whitish receptacle scar is commonly evident at the narrower extremity. Remnants of the pappus bristles often persist about the margin of the apex. Very fine, appressed, upwardly projecting hairs which thinly clothe the surface at maturity may or may not be present upon akenes found with commercial seeds.

These seeds are very apt to occur with poorly cleaned grass seeds

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Fig 45 —Horse-weed, Fleabane, *Erigeron Canadensis*. A, an akene. side view, enlarged. B, a group showing the natural size.

of the smaller kinds, and the lawn mixtures. They are not to be confounded with those of Yarrow, which are larger, notched at the apex, and striate lengthwise, or Ox-eye Daisy which are larger, not flattened, ribbed lengthwise, and commonly have a knobbed appendage at the apex.

POVERTY-WEED, *Iva axillaris* Pursh, is a plant very generally distributed throughout the West. While it prefers light, saline lands, it grows in a variety of soils. Its noxious character is due chiefly to its persistency in occupying ground upon which it has become established. Its leafy stems stand from six inches to a foot high and terminate in a slender, leafy cluster of small, drooping heads of insignificant flowers. Local distribution of the plants is accomplished chiefly by underground stems, hence they occur mostly in patches. Their eradication thus becomes difficult since the breaking of the subterranean, creeping stems only serves to increase their plant-producing power. The plant is very common in the streets, yards and pastures of western Nevada.

The *seeds* (akenes) are broadly and acutely egg-shaped, slightly flattened, and approximately one-twelfth of an inch in length. They taper to the acute base, and are either straight or curved slightly in the direction of one face. The edges are blunt or acute. The two scars are faintly evident. The surface is dull; and, commonly is from light to dark brown owing to the presence of a thin, scurfy, closely fitting and rather persistent covering to the black wall of the akene. The latter is microscopically granular and striated, but not evidently so under the ordinary lens.

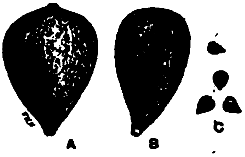

Fig. 46.

The seeds are not produced abundantly and are of secondary importance in the reproduction of this plant. They are not likely to occur with commercial seeds.

MARSH ELDER, *Iva xanthiifolia* (Fresen.) Nutt. This plant is very different from Poverty-weed. It is an annual which grows from three to six or seven feet high. As it has no creeping, underground stems, it propagates wholly by means of its seeds, which are said to be

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Fig. 46 —Poverty-weed, *Iva axillaris*. A, a side view, and B, an edge view of an akene, enlarged. C, group showing the natural size. No attempt is made to show in this figure the black, granular, striated surface proper.

produced in considerable quantity. It is a plant of the middle West, ranging from the northern to the southern boundary; and, in some localities, is considered a pest of grain fields and a plant capable of taking very complete possession of certain lands when permitted.

The *seeds* (akenes) of Marsh Elder are about one-tenth of an inch long. They are narrowly and acutely egg-shaped, and very slightly flattened, tapering from the broad, thickened, rounded apex to the acute base. The edges are commonly acute, sometimes faintly margined. The usually rounded faces are sometimes bluntly angled along the longitudinal center. The scars are commonly light colored, that at the apex often a projecting particle. The color is black, gray or brown, and dull. The surface proper is black, and under the ordinary lens, evidently granular and longitudinally striated. This, however, is often obscured by the presence of a thin, scurfy covering which gives the gray or brown color, and in being partially broken away, sometimes makes the akenes mottled.

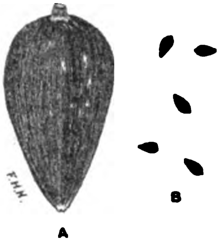

Fig. 47.

These seeds are liable to be found with the seeds of grains and the coarser clover and grass seeds grown in the middle-western States.

The true RAG-WEEDS belong to the genus *Ambrosia*. Two kinds have long been recognized pests of agriculture and are widely scattered over the country. However, they are not known to occur in western Nevada, although one of them seems to be present in the grain districts of northern California. They infest grain fields, pastures, waysides and neglected places, where they are unsightly and tend to impoverish the soil. Their flowers are of two kinds: the yellowish green staminate flowers forming small, drooping clusters; the seed-producing ones single or clustered in the upper leaf-axils, developing nutlet-like fruits, in which the involucre forms a nearly closed, outer case bearing characteristic teeth or spines.

The smaller RAG-WEED, *Ambrosia artemisiæfolia* L., bears the popular names, Roman Wormwood, Bitter-weed, Hog-weed and Rich-weed. It grows from one to three feet high, though sometimes taller

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Fig. 47.—Marsh Elder, *Iva xanthiifolia*. A, an enlarged side view of an akene. B, a group showing the natural size. The surface granulation and striation are intended to appear in this figure.

in the South. Its leaves are finely divided, in which respect they differ materially from those of *Ambrosia trifida.*

The *seeds* (fruits) vary in size from one-sixteenth to one-twelfth, or even two-twelfths of an inch in length. They are top-shaped, or the body portion sometimes almost spherical. The scar, showing the point of attachment to the plant, is usually distinct at the base of the fruit and commonly obliquely placed. A prominent ridge (keel) often extends from the lower edge of the scar along one side of the body. The apex terminates in a stout or slender beak which is from one-fourth to one-half the length of the body portion. The surface is usually faintly or distinctly narrow-ridged lengthwise, the ridges forming short teeth or spines about the upper margin of the body of the fruit. The number of ridges and teeth varies from four or five to ten, but commonly is from six to eight. The ridges and teeth may be very obscure or even wanting. The surface is, in some instances, faintly but coarsely and irregularly reticulate-ridged; or, it may be smooth. It may be more or less covered with appressed, whitish hairs, or free from them and roughened by their persistent bases. Further, the surface is dull and varies in color from straw-color to light or dark brown, or even black. The outer wall of the fruit is thin, becomes brittle, and often breaks away exposing the smooth, brown akene proper, which often has a faint, diffused luster. The wall of the akene is hard and unyielding, and is thicker than the involucral wall. The embryo is essentially the same as in the following species, *Ambrosia trifida.*

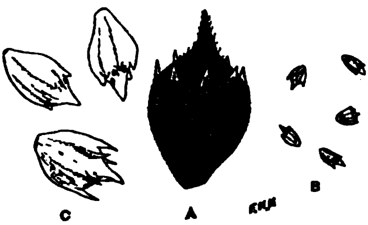

Fig. 48.

The seeds of this species of Rag-weed frequently form an ingredient of the seeds of the grains and the coarser grass and clover seeds, and it is very probable that they have been widely disseminated by means of them.

The statement at the close of the following description of the seeds of Great Rag-weed, quoted from the Bulletin of the Manitoba Depart-

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Fig. 48.—Rag-weed, *Ambrosia artemisiæfolia.* A, a fruit, enlarged. B, a group showing the natural size. C, a group indicating the variation in the form of the fruits. (The general character of the internal structure is shown at C, Fig. 49.)

ment of Agriculture and Immigration, is reported, in the article cited, as applying also to the seeds of this species.

Prof. Thomas Shaw, in his "Weeds, and How to Eradicate Them," states with reference to this species, as follows: "Rag-weed is distributed in the seeds of all the late-maturing cereals, and in the seed of mammoth and alsike clover, and of timothy. But it is most commonly distributed in the seed of common red clover; * *" The writer has found the seeds with Japan clover seed and Hungarian grass seed; also with wheat delivered in Reno and reported to be from the grain districts of northern California.

GREAT RAG-WEED, *Ambrosia trifida* L., is sometimes called Horse-weed, but is not to be confounded with the Horse-weed, *Erigeron Canadensis*, previously described (see p. 50). This coarse plant which grows from five to ten feet high in the North, is said to attain a height of sixteen or seventeen feet in the South. Its size and large, three- or five-lobed leaves readily distinguish it from the preceding plant.

The *seeds* (fruits) of Great Rag-weed are large, varying from one-fourth to nearly one-half an inch in length, and have a thick, outer case of woody texture. They are rather narrowly top-shaped, oval or egg-shaped, and are tipped by a tapering beak commonly about half as long as the body of the fruit. The latter is more or less prominently and coarsely five-ribbed lengthwise. Often alternating ribs are present, these sometimes as prominent as the primary ribs. The ribs project from the margin of the contracted apex as coarse teeth or spines, four or five to eight or ten in number. In the absence of secondary ribs, the surface between the others is smooth, tubercled, pitted or grooved, or slightly reticulate-ridged. The base of the fruit is obtuse and bears the circular, oblique scar. The surface is dull and smooth, or roughened by hair-tubercles; or, appressed, whitish hairs may be present. The color varies from light to dark brown. Within

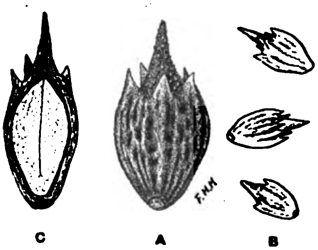

Fig 49.

Fig. 49.—Great Rag-weed, *Ambrosia trifida*. A, a fruit, enlarged. B, a group indicating the natural size and some variation in form. C, a section of a fruit taken lengthwise, showing the thick, outer wall and the embryo The thin wall of the akene proper appears about the caulicle of the embryo.

the thick, firm, outer wall, the thin, tough wall of the akene proper encloses a single seed whose embryo has large, thick cotyledons and a short caulicle.

It would seem that the large size of these seeds should permit their easy separation from all the field seeds with which they might occur. However, Bulletin No. 3, of the Manitoba Department of Agriculture and Immigration, 1897, "Noxious Weeds, and How to Destroy Them," states in connection with a description of this plant, as follows: "Still greater mischief is caused by the seeds which cannot be cleaned out of grain, and are such a nuisance to millers that wheat or oats containing any large proportion of these seeds are unsalable." Again, the same article states: "Investigation shows that the worst seed in flour and oat-meal mills, is that of the Rag-weed. Any variety of this is bad, as they are all much the size of wheat, and though broader than oats, are nearly the same length; but the worst is that of Great Rag-weed, which is furnished with several horns at the top, which catch in the meshes of the screens, and can scarcely be separated."

BUR RAG-WEED, *Franseria Hookeriana* Nutt., has attracted little attention from writers upon weeds. This is probably due to the fact that the plant is confined to the western part of the country, where it is reported as occurring from the northern to the southern boundary. In 1894, Prof. E. O. Wooton discussed it in Bulletin No. 13, of the New Mexico Agricultural Experiment Station, as "a rather aggressive field weed to be found more or less abundantly in most cultivated crops, unless the cultivation has been very careful and thorough." In several places about Reno, this plant seems to be acquiring all the essential attributes of a bad weed. It forms dense patches along the roadsides, seemingly preferring light, sub-alkaline soil. The number of plants in these spots has increased within recent years, and the presence of single plants in new localities each year indicates a more complete local distribution in the near future, in which the local history of Prickly Lettuce, False Flax and Gum-weed will probably be repeated.

The plant is an annual, growing from one to three or four feet high. The herbage of young plants has a silvered appearance due to a whitish, minute-hairy covering, and the leaves are rather finely divided. Slender clusters of drooping, staminate flower-heads terminate the branches. The fertile flowers, or burs, are scattered singly or in clusters along the stems below the others. Thus the plant has much the appearance of the Rag-weed, ***Ambrosia artemisiæfolia***, to which it is very closely related. Hence the name, Bur Rag-weed,* which has been applied to it, seems very appropriate.

The *seeds* (burs) of *Franseria Hookeriana* are structurally the same as those of the Rag-weeds in essential particulars. The average size of the burs is about one-fourth of an inch in length from the base to the tip of the terminal spine. The body is lance-shaped or oval. Projecting from the sides are straight or recurved rigid spines of variable number, which, in length, about equal the width of the body of the bur. The spines are flattened, and often grooved on the upper side at the base. They taper uniformly to the tip, which is of needle-like sharpness. A stout, straight, hollow spine terminates the bur at the apex. The surface of the body is usually wrinkled or grooved, often a distinct cavity occurring at the base of and above some of the larger spines. The surface is dull, the color varying from straw-color or yellow to light brown, the tips of the spines often darker. The wall of the bur is of rather moderate thickness and somewhat woody in texture. The wall of the single akene proper is thin. The embryo is similar to that of the Rag-weeds, but slenderer.

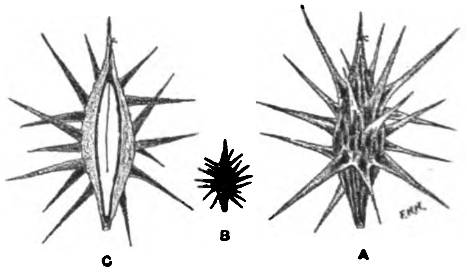

Fig. 50.

The sharpness of the rigid spines of these burs makes this a most noxious plant; and though the spines are not barbed, the burs are readily carried in the wool of sheep.

The CLOT-BURS, or COCKLE-BURS, are represented in Nevada by two distinct kinds recognized as pernicious weeds wherever they are found. They are rather coarse, woody-stemmed plants whose inconspicuous flowers are followed by rather large, seed-bearing burs which contribute largely to the noxious character of the plants. Both grow along roadsides, irrigation ditches and in neglected places. They are annuals which should yield readily to persistent prevention from seed-

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Fig. 50.—*Franseria Hookeriana*. A, a bur, enlarged. B, one showing the natural size of one of the largest of the burs. C, a section of a bur taken lengthwise, showing the character of the internal structure.

* Dewey, Yearbook, U. S. Department of Agriculture, 1895, page 594.

ing. The ripened burs, like those of Burdock, cause almost inextricable tangles in wool and the mane and tail of horses.

Of these two plants, the one designated by the names Clot-bur and Cockle-bur, *Xanthium Canadense* Mill., is to be distinguished by its broad, coarse leaves; and, in age, by its reddish stems and burs.

The *burs* are about one inch in length when well matured. Late-produced ones are apt to be smaller. Each consists of the hardened floral involucre, as in the preceding species of Rag-weed and Bur Rag-weed, and contains two enclosed akenes with their seeds, each in a separate cell. The body of the bur is hard and woody, and rather thick-walled. It is oblong, tapering at the base which exhibits the single scar, and terminated at the apex by two stout, straight, incurved, or at least inwardly hooked, spines. The surface is thickly, or in some instances sparingly, covered with rigid, radiating spines, each an eighth of an inch or more long. The spines taper uniformly and terminate in an upwardly curved, rounded, sharp-pointed hook. The surface of the bur, and the lower half of the spines, are roughened by a thick covering of fine, bristly hairs. The color is dull, reddish brown, the curved tips of the spines usually lighter. The slender embryos have very long cotyledons and a short caulicle. Each seed-cavity leads to a slender channel within a terminal spine, which communicates with the exterior in a notch in the inner side of the spine. The dried remains of the style-branches of the flower may often be found projecting from this channel. This structure is present in the fruits of the species of *Ambrosia* and *Franseria*, and the following species of *Xanthium*.

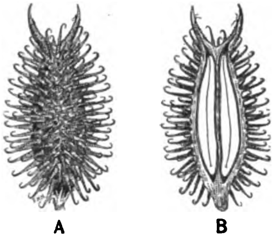

Fig. 51.

The size of these burs and the fact that their seeds always remain enclosed, precludes the distribution of this plant by means of commercial seeds.

Spiny Clot-bur, *Xanthium spinosum* L., is known in the North-west as Dagger Cockle-bur and Chinese Thistle. It is an introduced foreigner which has came to be well known in other countries. Its

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Fig. 51.—Clot-bur, *Xanthium Canadense*. A, an external view of a bur. B, a section of the same taken lengthwise, showing the two embryos in separate cells. Both A and B are natural size.

habits are similar to those of the preceding plant, but it may be easily recognized by its rather weak branches, its notched and pointed leaves being whitish beneath and dark, shining green above, and its very sharp, light colored, three-pronged spines. The latter add greatly to the noxious character of the plant.

The *burs* of this species are of the same nature as those of the preceding. These, however, are from one-third to one-half of an inch in length. The body is oblong and sometimes slightly flattened. The stout spines, or prongs, at the apex of the burs of *Xanthium Canadense* are represented in the Spiny Clot-bur by mere elevations of the surface, which are perforated to convey the style-branches. Beside one or sometimes each of these elevations, a single, straight spine arises. In some, neither of these spines is present. The surface is sparingly covered with slender prickles about one-twelfth of an inch long, which bend easily under slight pressure. Each of these is hooked (usually upwardly) at the tip, much in the manner of the conventional shepherd's crook. The body of the bur is dull and smooth, or sometimes bears some fine, whitish, appressed hairs. The surface is often somewhat elevated about the base of the prickles. The color is from light to dark brown or greenish. The prickles are smooth, light at the tip and darker below the middle: or, brown or reddish-tinged throughout. The internal structure is essentially the same as that of the preceding Clot-bur.

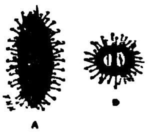

Fig. 52

These seeds, too, are not subject to distribution in commercial seeds, but are admirably adapted for at least local dissemination by range animals, particularly sheep.

The common SUNFLOWER, *Helianthus annuus* L., so commonly grown in gardens, where it often attains a great size, is represented throughout the West by smaller, wild plants. In moist seasons, these plants contribute much of the yellow, floral display of the wild land of the Truckee Valley and the surrounding hills. Fallowed land and grain fields often contain the plants in considerable quantity. They grow from a foot to four or five feet high, dependent largely upon the amount of available moisture.

The *seeds* (akenes) of the WILD SUNFLOWER are rather large and robust, and should be distinguished from other weed seeds without

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Fig. 52.—Spiny Clot-bur, *Xanthium spinosum*. A, a bur bearing a single terminal spine, natural size. B, a cross section of the same.

great difficulty. Those produced by plants growing in western Nevada, and also such as the writer has found mixed with grain seeds from other places, are commonly about one-fourth of an inch in length. Seeds from larger, wild plants probably exceed this length, as do those of the cultivated forms; and, perfect seeds not exceeding one-sixth of an inch long are of not infrequent occurrence. All are broadly or narrowly oblong-egg-shaped in outline, flattened with rather acute profile edges, and thick or even angled along the longitudinal center. Though mostly straight, some are curved edgewise. The scar at the narrow base is indicated by a slight notch. At each side of the latter, the edge is covered by a smooth, often whitish callosity, that at one side larger than the other and forming an evident protuberance. The sçar at the apex is small with a slightly elevated, circular margin. The surface is dull. It may be covered by very fine, appressed, whitish hairs; or, simply very minutely scurfy from the presence of a thin, outer covering. A fine, longitudinal striation is usually evident. The outer covering is often partially broken or rubbed away, exposing the dull, black, granular surface proper which shows the striation more distinctly. The thin covering gives the gray or light brown color which usually predominates, with variable bands of black lengthwise, also scattered spots of black giving the akenes a mottled appearance. Fine, silky hairs may be present about the apex, even though absent elsewhere.

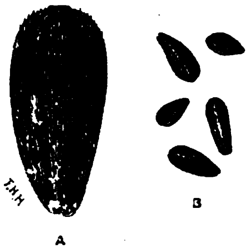

Fig. 53.

The seeds occasionally occur with those of the grains. They are probably uniformly smaller than the seeds of the cultivated Sunflowers, which they resemble in other respects, except in the matter of color in the case of one white-seeded variety.

The BUR-MARIGOLDS are represented in Nevada by two kinds of plants growing in wet places. Small irrigation ditches are often nearly clogged by these plants. One of them, known as STICK-TIGHTS, PITCHFORKS and BEGGAR'S TICKS, *Bidens frondosa* L., has a widespread reputation as a weed. Its slender stems having spreading, open leaves, are terminated by inconspicuous flower clusters, and stand from two to five feet high. The common names are accounted for in the

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Fig. 53.—Wild Sunflower, *Helianthus annuus*. A, an enlarged side view of an akene. B, a group showing the natural size of different forms.

peculiar, barbed, seed-bearing fruits produced by this plant and its allies, and which persistently cling to clothing.

The *seeds* (akenes) of Stick-tights are broadly egg-shaped or oblong in outline and bear two slender, rather weak awns from the corners of the apex. They are flattened and thin, particularly the latter at the edges, one face often sloping from the center to the edges; or, they may be distinctly concavo-convex lengthwise. They vary from three-twelfths to five-twelfths of an inch in length exclusive of the awns, which are about half the length of the body of the akene. The broadest ones are shortest. Each face has a central ridge lengthwise which usually projects slightly at the apex, and sometimes, also, one or two faint ones on each side of the central ridge. The surface is more commonly finely tubercled than smooth, with fine, appressed hairs from the tubercles, pointing toward the apex. The slender awns are broad at the base and bear downwardly pointing, coarse, stiffish hairs. The scar at the base is surrounded by an elliptical, callous ring. That at the apex is a minute, circular projection at the center of the depressed, rounded notch between the awns. The akenes are dull, and light or dark brown, the awns often reddish tinged.

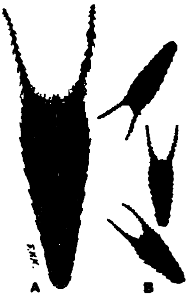

Fig. 54.

The size, lightness and barbed awns of these seeds commonly prevent them from appearing with commercial seeds.

Smaller Bur-Marigold, *Bidens cernua* L., is a conspicuously yellow- and nodding-flowered plant which grows one or two feet high in wet places. The writer believes it has increased greatly in western Nevada within the past few years Within the Truckee Valley, it seems to rival the better known Stick-tights in its weedy tendency.

The *seeds* (akenes) are smaller than those of *Bidens frondosa*, varying from three-sixteenths to one-fourth of an inch in length, exclusive of the awns, of which the longer are about one-half the length of the akene proper. They are wedge-shaped and thickest and broadest at the base of the spreading awns. From two to four rigid,

Fig. 54.—Stick-tights, Pitchforks, *Bidens frondosa*. A, a side view of an akene of intermediate form, enlarged. B, a group showing the usual natural size.

mostly straight awns project from the apex, the two continuing the edges of the akene longest. Each face is angled along the center by a prominent ridge, one or both of these often prolonged at the apex forming awns. Two or three faint ridges may occur on each side of the central ridge of each face. The surface is otherwise smooth and commonly sparingly and downwardly bristly barbed, particularly on the edges and central ridges of the faces. The awns are similarly barbed, the barbs appearing on both sides of the longer awns, or often only on the inner side. The raised surface of the apex bearing the minute, projecting, floral scar in the center, with the awns, is smooth and polished and lighter colored than the dull brown of the body of the akene.

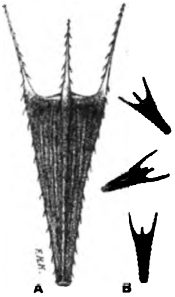

Fig. 55.

These seeds, too, are not apt to be found with commercial seeds.

Tar-weed, *Madia sativa* Mol., and its variety *congesta* T. & G., occur commonly on the Pacific Coast. The plants grow from one to two or three feet high, and have inconspicuous flower-clusters. A very sticky surface is rather characteristic of these plants. The species is found in western Nevada, but usually on wild land, so is not generally considered a weed in this region.

The *seeds* (akenes) might be mistaken for some unusual forms of Sunflower seeds. They vary in length from one-eighth to three-sixteenths of an inch. There are two rather well defined forms in which all are more or less flattened. Some are narrowly, and in being curved, unsymmetrically egg-shaped, broadest at the apex. The faces are flat or have a slight central ridge. The convex edge is thickest. The scar at the apex is small and slightly knob-like. That at the base is in a slightly one-sidedly placed notch, the convex edge somewhat extended, forming a hook-like appendage. This extremity is not callous-edged as in the seeds of Sunflower. Akenes

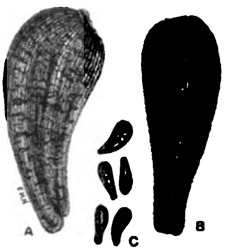

Fig. 56.

Fig. 55.—Smaller Bur-Marigold, *Bidens cernua*. A, a side view of an akene, the central ridge of the nearer face prolonged forming an awn. B, a group showing the natural size.

Fig. 56.—Tar-weed, *Madia sativa*. A and B, two forms of akenes, enlarged. C, a group showing the natural size.

of the other form are nearly straight with the faces distinctly angled or prominently ridged along the center. They are somewhat narrower than the others and the basal scar is at the center of the extremity. The scar at the apex is a slightly evident projection. The surface is usually mottled with numerous black spots appearing through a thin, outer covering which is gray or has a faint, bronzy luster under the lens. In many specimens, this covering is almost or quite absent, when the dull, jet-black surface proper is shown to be granular and finely striated lengthwise. The striations are commonly evident through the surface-covering which is never hairy.

The seeds are to be distinguished from those of Sunflower in being less robust, free from hairs, not banded with black and often having a bronzy luster.

This plant is adapted for growth in grain fields, and thus its seeds might occur with the seeds of the grains.

MAY-WEED, DOG'S FENNEL, *Anthemis Cotula* L., is a plant of European origin which has spread over this and many foreign countries. It is not so common in western Nevada as elsewhere, yet thrives in restricted localities in the Truckee Valley. It is a plant of roadsides, meadows and pastures, which may be recognized by its rather disagreeable odor, finely divided leaves and white flowers, each having a raised, yellow center. Few weeds have been more generally noticed by writers than this. It should be recognized and prevented from becoming established in Nevada.

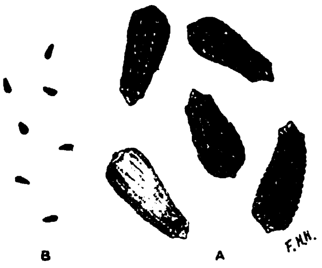

Fig. 57.

The *seeds* (akenes) are very small, being about one-sixteenth of an inch in length, with some variation in different specimens. They are broadly club-shaped and usually slightly curved, or occasionally straight and narrower. The surface is more or less distinctly ten-ribbed lengthwise or rarely smooth. The ribs are sometimes smooth, but more commonly distinctly though sometimes sparingly tubercled. Some specimens are very rough in being thickly tubercled and glandular. The tubercles at the base of the akene are commonly strongest. This extremity is tipped by a smooth, nipple-like projection which

Fig. 57.—May-weed, *Anthemis Cotula*. A, a group of seeds, showing the prevailing forms. B, a group showing the natural size.

constitutes the basal scar. The rather broad, rounded apex bears its slightly projecting scar in the center. The surface is dull and varies from straw color to light or sometimes dark brown. The basal scar is commonly light in dark specimens.

Owing to the wide distribution of this plant and its habits of growth and seed production, together with the size and weight of its seeds, the latter form one of the commonest ingredients of the smaller clover and grass seeds, particularly white clover and timothy.

YARROW, MILFOIL, *Achillea Millefolium* L., is an ill-scented plant of meadows, lawns and waysides, everywhere. Its erect stems are two or three feet high and are terminated by flat, crowded clusters of white or pinkish flower-heads. The leaves are finely divided and are somewhat fern-like in appearance

The *seeds* (akenes) of Milfoil are small and thin with narrow, lateral margins which are usually indicated by the color. The approximate length is one-twelfth of an inch and the usual general outline is oblong egg-shaped. They are commonly straight, but sometimes are slightly curved, particularly in the direction of one face. This face thus usually exhibits distinctly the minute, circular scar at the base. The broad apex has rounded corners and is broadly notched at the center. From this notch, the scar of this extremity projects slightly or as a knobbed appendage somewhat as in the akenes of Ox-eye Daisy. The surface is very finely wrinkled or striated lengthwise. It is dull, or in some specimens glistens slightly under the lens. The thin wall of the akene permits the seed proper being discerned in most instances. This gives the otherwise white or yellowish akenes a grayish color.

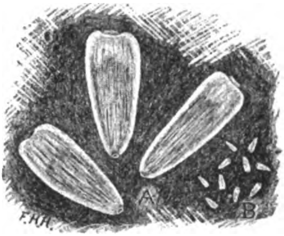

Fig. 58.

These seeds occur frequently among the grass seeds, particularly the smaller kinds, as those of the common lawn mixtures.

The OX-EYE DAISY, or WHITE-WEED, *Chrysanthemum Leucanthemum* L., is one of the best known weeds of meadows and pastures in the East. It is said to be increasing westward and is now found in scattered localities throughout the West. It is a perennial plant which spreads locally by means of both underground stems and seeds. It

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Fig. 58.—Yarrow, Milfoil, *Achillea Millefolium* A, three common forms of akenes, enlarged. B, a group showing the natural size.

stands from a foot to two feet high, the stems and branches terminated by white, yellow-centered flower clusters, each from one to one and one-half inches in diameter.

The *seeds* (akenes) of Ox-eye Daisy, though very small, are very characteristic of this weed, and should be readily recognized. Average specimens are approximately one-twelfth of an inch in length, but there is evident variation in the size. They are rather broadly club-shaped and scarcely flattened. Straight and somewhat curved specimens are equally common. Their most conspicuous characters lie in the ten well defined, narrow, whitish ribs or ridges which connect the two extremities, and the knob-like scar-appendage which projects from the broader apex. The black surface between the ridges is more or less minutely whitish-speckled. The scar at the bluntly pointed base is merely evident. Fresh specimens have a slight reflection under the lens. In some, the commonly whitish ribs and scar-appendage, particularly the latter, may be yellowish or even light brown. The usual general color is grayish. These seeds occurring with commercial seeds often have the scar-appendage broken away.

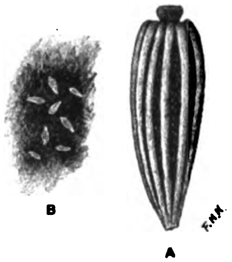

Fig. 59.

Ox-eye Daisy seeds are very common among the smaller grass seeds and possibly white clover seed.

Matricaria inodora L., is a plant very closely allied to the Ox-eye Daisy, which has become established in some parts of the East. Its seeds have been found in commercial seeds by the writer, though whether these samples were of American or European origin, cannot be stated. It is probable, however, that the seeds of this plant are the more common with European seeds.

The *seeds* (akenes) are very similar in their structural markings, but vary in length from one-sixteenth to one-twelfth of an inch. The smaller, narrower ones are straight and rather prismatic in form with truncate ends. The larger ones are relatively broader and are commonly curved in the direction of one face. They are sufficiently flattened to present two faces. Three well defined, broad ribs extend lengthwise along the usually concave face, broadly connected at the

Fig. 59.—Ox-eye Daisy, *Chrysanthemum Leucanthemum*. A, an akene, enlarged. B, a group showing the natural size.

apex and meeting at the base. Two of these are marginal, the other lying along the center. The opposite, convex face exhibits the marginal ribs and a short, partial, central rib leading from the apex, its extremity free or connected to the marginal ridges below two deep depressions separated by this rib. The surface between the ribs of each face is brown or black and strongly transversely wrinkled. The apex is concave with the minute scar-appendage in the center. Its margin is somewhat expanded and acutely edged. The scar at the base is merely evident. The ribs and their connections are light brown. The suface is dull and has a very fine, longitudinal striation sometimes evident.

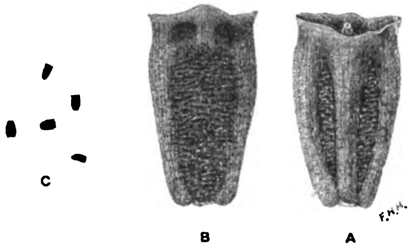

Fig. 60

BURDOCK, *Arctium Lappa* L., is a coarse, large-leaved, biennial plant of the East and scattered localities of the West. It grows from one foot to five feet high and prefers the rich soil usually found about dwellings and in enriched pastures. Its purple-flowered flower-clusters ripen into the most typical kind of burs which rival the Clot-burs in their capability to tangle wool and the mane and tail of horses. By this means, their seeds are, at least locally, distributed. A few plants ound at Glendale in the Truckee Valley, in 1894, disappeared without establishing new plants.

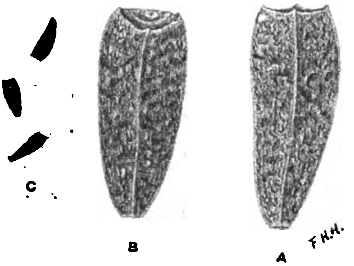

Fig. 61.

The *seeds* (akenes) of Burdock are oblong-prismatic with from three to five narrowly ridged angles, and occasional, slight, secondary ridges on the faces. They are from three-sixteenths to one-fourth of an inch in length, with truncate extremities. Some are straight, others curved

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Fig. 60.—*Matricaria inodora*. A and B, views of the two faces of one of the larger, broader akenes, enlarged. C, a group showing the natural size.

Fig. 61.—Burdock, *Arçtium Lappa*. A, a side view of one of the inner akenes of a bur; and B, showing the inner surface of a curved, outer akene and exhibiting the character of the apex, both enlarged. C, a group showing the natural size.

edgewise, and still others (the outer ones of the flower-cluster) curved in the direction of the principal faces. All are more or less flattened. The surface is roughened and somewhat mottled by numerous and irregular elevations of a brown covering to the thick, black wall of the akene. The narrow base is occupied by the flat, faintly margined scar. The margin of the apex is acute and slightly toothed by the projecting ends of the ridges of the surface angles. Within a more or less distinct, brown ring concentric with this margin, is the slightly projecting apex-scar. The seeds are dull and the general color is light brown.

Commercial seeds are said to occasionally contain the seeds of Burdock, but its dissemination is doubtless accomplished chiefly through its seed-bearing burs, in one way or another.

The CANADA THISTLE, *Carduus* (*Cnïcus*) *arvensis* (L.) Robs., is known in some parts of the country as Cursed Thistle and Creeping Thistle. It is a plant originally introduced from Europe, and is said by some writers to have come by the way of Canada, whence its most widely known, popular name. The plant is well known in the East and is gradually spreading westward. So far as the writer knows, it does not occur in Nevada, however. Unlike most of the thistles, this is a perennial, living from year to year and spreading locally by means of underground stems. Thus patches are formed when the plant becomes well established. Individual plants stand from one foot to three feet high. Its purple or white flowers are diœcious; that is, certain plants produce only staminate flowers which do not develop seeds. Again, it is probable that the subterranean stem-system results in a less prolific seed-production. As a result, the plants of some sections of the country produce few or no seeds. Notwithstanding, the plant is generally considered a most pernicious weed, greatly dreaded by farmers.

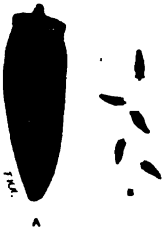

Fig. 62.

The *seeds* (akenes) of Canada Thistle are approximately one-eighth of an inch long. They are somewhat narrowly lance-shaped in outline, tapering to the rather bluntly pointed base which bears the merely evident scar. They are flattened, thickest along the longitudinal center, the edges being blunt and rounded. The apex is truncate, and

Fig. 62.—Canada Thistle, *Carduus arvensis*. A, a side view of a single akene, enlarged. B, a group showing the natural size.

cup-shaped in being margined by a narrow, often expanded rim beneath which the akene is more or less constricted. At the center of the concave apex, the scar appears as a relatively conspicuous, projecting appendage. The akenes are straight or nearly so. The general surface is smooth and usually exhibits several slender, shallow, longitudinal grooves. It is dull or has a slight, diffused reflection under the lens. A few slender ridges may be present about the base. The color is light brown, the marginal rim at the apex usually lighter and the scar-appendage darker.

The adaptability of the various commercial seeds for transporting the seeds of Canada Thistle makes it especially desirable that the appearance of the seeds should be well known, thus making possible the prevention of their introduction to new localities.

Prof. Thomas Shaw's "Weeds and How to Eradicate Them" under the discussion of this plant, continues as follows: "Its seeds are not only wafted incredible distances by the wind, but they are also distributed everywhere by means of the seeds of all kinds of cereal grains and of several of the clovers and grasses, * *"

CHICORY, or SUCCORY, *Cichorium Intybus* L., is a coarse, perennial-rooted plant becoming "abundant eastward" as a weed of roadsides and fields. Its thick, fleshy root, and straggling stems and branches bearing closely placed, blue or whitish flower-clusters are its chief characters to be noted by casual observation. It usually stands from one to four feet high. Its dried and ground roots are much used as a substitute for or adulterant of coffee, and it is closely related to the endive of gardens. Several patches of this plant within the Truckee Valley have persisted from year to year, but do not seem to have spread to any evident extent.

The *seeds* (akenes) of Chicory are very similar to those of endive. Like many others of the Compositæ, they exhibit two rather distinct forms dependent upon their positions in the flower-cluster. Those from the outer part of the cluster (A, Fig. 63) are more or less oblong-egg-shaped with the extremities, particularly the apex, truncate. They are somewhat flattened, and commonly curved in the direction of one face. The convex face is smooth or slightly ridged lengthwise, or distinctly once or twice angled. The inner akenes of the cluster (B, Fig. 63) differ from the others in being slenderer, straighter and commonly longer. They are scarcely flattened, variously ridged and usually distinctly four- or five-angled. Occasional intermediate forms occur.

The approximate length of the various akenes is from one-twelfth to one-eighth of an inch. The apex is abruptly truncated, sometimes somewhat obliquely so. Just within the margin, is a very persistent crown of numerous, minute, whitish scales (the pappus). These usually consist of a double row which surrounds the minute, projecting scar of this extremity. The opposite extremity is occupied by the rounded, light colored, basal scar, which becomes very small in the tapering, more pointed specimens. The surface is usually very numerously and minutely ridged crosswise. It is dull and varies from very dark brown to straw-color, and is often distinctly mottled.

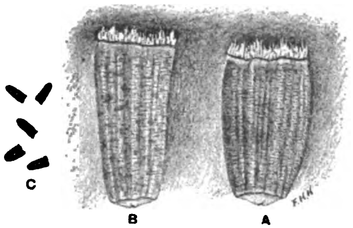

Fig. 63.

The seeds of Chicory are very apt to be found with various commercial seeds grown where this weed has become established in fields. The unusually persistent pappus is sometimes partially or even wholly broken away by severe threshing.

Salsify, or Oyster-plant, *Tragopogon porrifolius* L., is the garden vegetable-oyster which has escaped from cultivation and run wild. It has thus become a weed of meadows, pastures and waysides in various parts of the East and on the Pacific Coast where it is said to have become naturalized in California and Oregon. It has become rather common in the Truckee Valley, occurring in various situations. Recently, it has been submitted at the Experiment Station as a persistent weed of alfalfa meadows. The plants stand from one to three or four feet high. It has a coarse, white, tapering root. The narrow, upright leaves are somewhat grass-like, and the large, purple flower-clusters terminate the stems and branches and open chiefly in the morning. The large, light brown fruit-clusters resemble somewhat those of Dandelion.

The *seeds* (akenes) of Salsify are sub-cylindrical, tapering at the apex. The usual length of the akenes proper varies from one-half to five-eighths of an inch. Evident variation in form, surface markings and color is due to the different positions in the flower-cluster occupied by the akenes. All, "except perhaps the outermost," at maturity,

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Fig 63.—Chicory, *Cichorium Intybus*. A and B, the two prevailing forms of akenes, enlarged. C, a group showing the natural size

terminate in a slender beak which about equals in length the akene proper. The coarse, light brown pappus consists of slender bristles connected by cobwebby hairs. The beak readily breaks away at maturity leaving only its persistent base. The akenes are evidently but slenderly ten-ribbed lengthwise, the ribs and resulting grooves of the apex often somewhat spiral. The outermost akenes are coarsely roughened by upwardly directed, whitish, scale-like projections. These are strongest on the ribs, smaller ones occurring in the intervening spaces. These akenes are dark brown, or gray from the presence of the whitish projections. Others are similarly roughened on the ribs only, and the innermost ones of the flower-cluster are but slightly roughened on the ribs near the apex, or are smooth. These are dull, and mostly light brown in color. The outermost akenes are robust, often somewhat spindle-shaped, and are curved, chiefly at the base. Other forms are slenderer and less curved. All are obliquely truncate at the base which is cup-shaped with a slender scar-appendage projecting from the center.

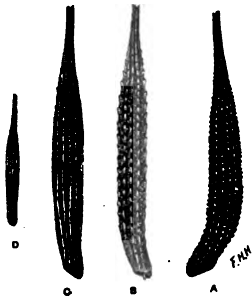

Fig. 64.

Owing to their peculiarly buoyant pappus, these seeds are admirably adapted for local distribution by the wind. Only the coarsest grain and grass seeds, if any, would be apt to contain them as an ingredient.

The Dandelion, *Taraxacum Taraxacum* (L.) Karst., is supposed to be familiar to every one owing to its widespread distribution throughout the United States. That it does not yet occur in all settled parts of Nevada may be rather safely assumed from the fact that students from some sections of the State assert that they are unacquainted with it. Again, pioneers of the State claim that the Dandelion was formerly unknown where it is now common. It is fast becoming a most serious weed of Nevada alfalfa fields and lawns. The weak condition of many fields and lawns permits the Dandelions to crowd out the remaining desirable plants. As a result, both situations exhibit in early summer great patches of golden-yellow flowers in the mornings

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Fig. 64.—Salsify, Oyster-plant, *Tragopogon porrifolius*. A, B and C, three forms of akenes taken, in the order given, from the outermost to the innermost part of the flower-cluster, enlarged. D, one showing the average size.

and of white, downy seed-clusters in the afternoons. Wind and water together carry the seeds everywhere and only the strongest meadows and lawns will successfully resist the invasion of this plant.

The *seeds* (akenes) of Dandelion are lance-shaped in geneal outline, and are straight or perhaps more commonly slightly curved edgewise. They are approximately one-eighth of an inch long exclusive of the short persistent base of the beak, which slightly increases this length. They are much flattened, thickest through the longitudinal center, the edges being acute. The smaller extremity is slightly hollowed forming the indistinct basal scar. The apex is rather abruptly terminated by the short, stout, tapering base of the beak. The beak. at maturity, is thread-like and between two and three times the length of the akene. Its fragile pappus makes an ideal parachute for the transportation of the seeds. The most conspicuous structural character of the akenes lies in the barb-like-toothed edges and ridges of each of the similar faces. Besides the ridges of the margins, each face of typical specimens exhibits five longitudinal ridges. Of these, the central one is commonly coarsest, the two narrower ones on each side being separated by a narrow but deep groove which is continued along the base of the beak. All the ridges are upwardly toothed at the apex, the diminishing teeth often extending quite to the base, particularly in the case of the secondary ridges. Occasionally, extra ridges are present on the faces, sometimes at the expense of the otherwise coarser, central one. The surface of the ridges and teeth is smooth or microscopically appressed-scaly. The akenes are dull and the color varies from light to dark brown.

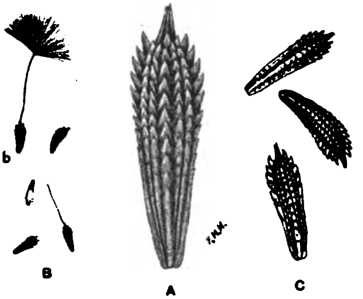

Fig. 65.

The almost universal presence of the Dandelion minimizes the importance to be attached to the distribution of its seeds with the commercial seeds, among which they are found to some extent.

Fig. 65.—Dandelion, *Taraxacum Taraxacum*. A, an enlarged view of one of the two similar faces of an akene, in which no attempt is made to show the minute surface-scales which are not evident under the ordinary lens. B, a group of seeds, natural size. **b**, one bearing the beak and pappus. C, a group showing common variation in the form of the akenes.

Prickly Lettuce, *Lactuca Scariola* L., bears also the popular names Compass-weed and Milk Thistle. Each of the common names is justified by some evident character exhibited by the plant. It is an annual which has been considered by students of plant ancestry as the original form of the cultivated varieties of garden lettuce. This fact and that of the prickly nature of the midrib of the leaves on the lower side, has given rise to the generally accepted name Prickly Lettuce. In order to permit an equal exposure to the light of both surfaces of the leaves, each of those of the stem is twisted at the clasping base sufficiently to stand vertically and usually evidently in the meridional plane, whence the common name Compass-weed. Its milky juice and sharply toothed leaf-margins taken together have contributed the name Milk Thistle. The stems branch from the top at from one to five or six feet from the ground. The inconspicuous, yellow flower-clusters open, a few daily, in early morning and develop by autumn an immense number of seeds which are wafted long distances by the wind. During thirty-five years, Prickly Lettuce has traversed the country from the Atlantic to the Pacific and has established many permanent colonies on the way. In 1892, the writer found it within the Truckee Valley for the first time, as a ballast plant on the line of the Central Pacific railroad. Since then, it has become one of our commonest weeds, occurring abundantly in all situations.

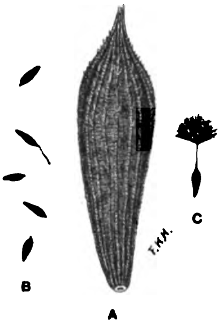

Fig. 66.

The *seeds* (akenes) of Prickly Lettuce are very similar to those of garden lettuce, especially the dark seeded varieties. They are lance-shaped or broadly so, and straight or slightly curved both edgewise and in the direction of the faces. The difference in appearance of individuals lies chiefly in their length which varies from one-eighth to one-sixth of an inch. All are much flattened with acute, slightly margined, lateral edges. The evidently convex faces are similar, and are from five- to seven-ribbed lengthwise by narrow ridges, exclusive of the rib-like margins. The surface is otherwise roughened, particularly on the ridges and margins; also finely whitish-hairy about the broader apex (if the hairs have not been

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Fig. 66.—Prickly Lettuce, *Lactuca Scariola*. A, a side view of an akene, enlarged. B, a group of the same, natural size. C, an akene bearing its beak and fragile pappus.

rubbed away by friction with other seeds). The scar at the base is represented by a whitish, circular, callous, scarcely projecting ring. The apex is acutely tipped by the short, persistent base of the beak which in its entirety about equals the length of the akene. The surface is dull, dark brown, and usually mottled with patches of black.

These seeds are very apt to occur with many commercial seeds, and are to be distinguished from those of the commoner cultivated varieties by their color (except in the case of the dark seeded varieties) and the fewer ribs on each face. Moreover, they are mostly smaller and the basal scar less conspicuous.

Lactuca Canadensis L., known as WILD LETTUCE and by several other even less distinguishing popular names, as Trumpet-weed and Fire-weed, is a common plant of unoccupied ground in certain parts of the East.

Its *seeds* (akenes) are much flattened with thin edges, broadly or narrowly oval, and approximately one-eighth of an inch long, or one-sixth of an inch including the persistent base of the beak. They may be straight or slightly curved edgewise or facewise. The similar faces have a narrow, sometimes faint ridge lengthwise through the center, and are often faintly ridged or broadly grooved near and parallel with the edges, thus indicating the inner border of the true, wing-like margins. The apex is acutely tipped by the persistent base of the beak, while the base of the akene projects slightly beyond the border, and is truncate, hollowed and slightly callous edged about the scar. The surface is very finely rough-ridged crosswise, the ridges rather evidently radiating from near the center of each face. The color is black or very dark brown and dull, the projecting base lighter. The light-colored beak of freshly matured specimens about equals or is rather shorter than the akene proper.

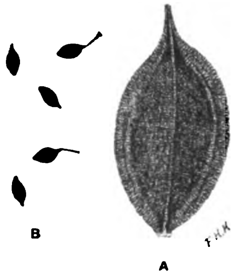

Fig. 67.

These seeds are distributed in the same manner as those of Prickly Lettuce, but perhaps to a less extent by means of commercial seeds.

ORANGE HAWK-WEED, *Hieracium aurantiacum* L., is a mountain plant of Europe which has found a place in American gardens

Fig 67.--Wild Lettuce, *Lactuca Canadensis*. A, a side view of an akene, enlarged. The roughness of the minute cross-ridges is not shown, as it is scarcely evident under the lens. B, a group of akenes, natural size, two of them showing the beak.

owing to its striking, flame-colored flowers. In New England and later in Ohio, it has assumed the role of a weed so successfully as to have acquired the popular name Devil's Paint-brush. It is proving a serious destroyer of meadows and pastures through its ability to thoroughly occupy the ground by means of spreading runners as well as by seeds. The latter are produced in abundance at a time when they are readily retained by seed hay.

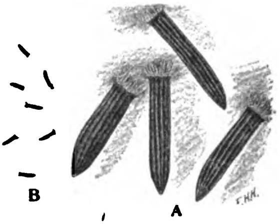

Fig. 68.

The *seeds* (akenes) of Orange Hawkweed are very small, varying from one-sixteenth to one-twelfth of an inch in length. They are broadly or narrowly oblong and not flattened, and straight or curved. The apex is truncate, commonly with a slightly expanded border. The base tapers to the acute extremity which bears the minute, whitish scar, slightly at one side in most instances. The dull, jet-black or very dark brown surface bears ten narrow ridges lengthwise. Immature seeds are reddish-brown. The lower portion of the whitish pappus bristles usually remains at the apex, projecting from just within the margin.

These seeds occur frequently among grass seeds and thus are very apt to find their way into the agricultural districts of Nevada, where the natural conditions might aid this plant in becoming a great nuisance.

SOW THISTLE is the common name applied to three different plants belonging to the genus *Sonchus*, which closes the present list of weeds of the Composite family.

Two of these plants are annual weeds of waysides, meadows and pastures nearly the civilized world over, not excluding Nevada. The writer does not know that the third, a perennial plant, occurs within the State. They have somewhat the aspect of the true thistles, but are slenderer. All have downy plumed akenes.

Sonchus asper (L.) All., is called Spiny Sow Thistle because of its stiffish, prickly toothed leaves. The clasping bases of the upper leaves are rounded in this, the commoner of the two kinds found in western Nevada. It grows from two to five feet in height, often in dense patches along country roadsides and the margins of meadows.

Fig. 68.—Orange Hawk-weed, *Hieracium aurantiacum*. A, a group of akenes, enlarged, showing the common variation in form and the persistent, partial pappus bristles. B, a group showing the natural size.

The *seeds* (akenes) of *Sonchus asper* are very thin, but differ considerably in outline owing to the presence or absence of a wing-like margin. Thus they vary from broadly oblong to lance-shaped, those of the latter form being merely narrow-margined at the edges. The length of the broader specimens approximates one-eighth of an inch, that of the narrower ones often not exceeding one-twelfth of an inch. The two faces are similar, each bearing three narrow ridges which meet at the extremities. The latter are similar, each consisting of a slightly thickened, collar-like portion of or projection from the border in the broader specimens, the structure in the narrower specimens being essentially the same. The surface is smooth or the broad margins slightly ridged and grooved lengthwise. the latter and the three ridges often being faintly roughened crosswise near the base. The color varies from straw-color to reddish brown, the broader specimens commonly darkest.

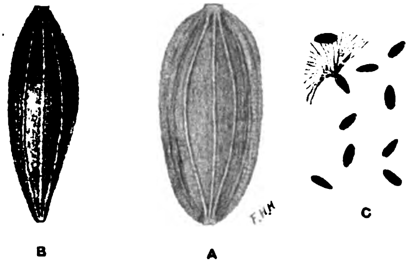

Fig. 69.

The seeds often occur with grass seeds, when the thin, brittle margins of the broader seeds are often jagged-edged in being partially broken away.

Sonchus oleraceus L., bears the popular name Common Sow Thistle. Its general aspect is similar to that of the preceding species. Its lower leaves are deeply cut, the clasping lobes of the base in the upper leaves pointed instead of rounded. Within the Truckee Valley, this plant infests orchards and cultivated fields.

The *seeds* (akenes) are linear-lance-shaped and flattened, but relatively not so thin as those of *Sonchus asper*. Their approximate length is one-eighth of an inch. The edges are acute and not evidently margined. The extremities are obtuse, the apex bearing a slight, collar-like projection surrounding the scar. Each of the similar faces is faintly or clearly but lightly five-ridged lengthwise, one ridge along the center and two on each side of it midway to the edge and separated

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Fig. 69.—Spiny Sow Thistle, *Sonchus asper*. A, one of the broader, wing-margined akenes, and B, one of the narrower, but slightly margined form, both enlarged. C, a group showing the natural size, one bearing the pappus.

by a narrow, deep, and almost invariably evident groove. Each face thus presents, as its most evident character, two slender grooves extending from one extremity to the other. Sometimes the outermost ridges are so indistinct as to give the impression that the faces are three-ridged as in *Sonchus asper*. The surface is dull, microscopically striate and finely wrinkled crosswise, or occasionally nearly smooth between the ridges. The rough edges are often microscopically and downwardly bristly. The color varies from straw-color to reddish brown, the projecting apex lighter.

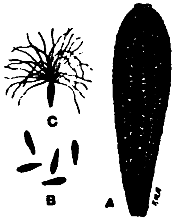

Fig. 70.

These seeds are very apt to occur among the grass seeds.

Sonchus arvensis L., is known as Corn Sow Thistle and Perennial Sow Thistle, and, as the latter name indicates, differs from the preceding annual species in persisting from year to year. It spreads locally by underground stems, which fact and that of its natural aggressiveness make it a far more serious plant than either of its annual allies. Thus it becomes important to prevent, if possible, the introduction of its seeds.

The *seeds* (akenes) of *Sonchus arvensis* are structurally similar to though coarser than those of *Sonchus oleraceus*. They are oblong with rather blunt extremities and are thick-margined. The length commonly exceeds one-eighth inch and they are often slightly curved edgewise. While much flattened, they are thicker than the akenes of either of the preceding species of *Sonchus*. The two faces are essentially alike, each bearing five coarse, fold-like ridges connecting the extremities. Of these, the central one is commonly strongest. The narrow grooves of the akenes of *Sonchus oleraceus* occur in like position in these and are sometimes evident at the margin of the base. The surface is finely wrinkled crosswise, and, like that of *S. oleraceus*, microscopically (sometimes evidently) striated lengthwise. The color is dull, dark reddish brown, the slightly projecting apex lighter.

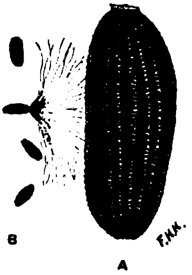

Fig. 71.

Fig 70.—Common Sow Thistle, *Sonchus oleraceus*. A, an akene, enlarged, showing the prevailing form. B, a group showing the natural size. C, one bearing the pappus, natural size.

Fig. 71.—Perennial Sow Thistle, *Sonchus arvensis*. A, an akene, enlarged. B, a group showing the natural size, one exhibiting the pappus.

In "Weeds and How to Eradicate Them," Prof. Shaw, in discussing this plant, writes: "Moreover, its seeds, like those of Canada Thistle, are constantly being widely distributed by being carried about with the seeds of cereals, clovers and grasses."

INDIAN HEMP, DOGBANE, *Apocynum cannabinum* L., grows in the damp ground along the Truckee river, but would hardly be called a weed, as it is not at all aggressive. Its general aspect and milky juice remind one of the Milk-weeds, but its slender seed cases are in pairs, each in-curved. Dr Byron D. Halsted, in the Report of the Botanical Department of the N. J. Agricultural Experiment Station, for 1892, says: "Large areas of grass land sometimes become infested with this, to the exclusion of nearly everything else." Profs. Hitchcock and Clothier, in their bulletin on "Kansas Weeds," No. 80, 1898, state that this plant is "often very troublesome in cultivated fields."

The *seeds* of Indian Hemp are slender and straight or slightly curved, pointed at the base and blunt at the apex, or tapering upward, thus somewhat spindle-shaped. They vary in length from three-sixteenths to five-sixteenths of an inch. The surface is finely roughened and dull, and is more or less angularly compressed lengthwise. The base is often slightly wing-tipped. The margin of the apex is often slightly expanded, and also roughened. The color is reddish brown, lighter upon the apex. When first discharged from the seed vessel, the seeds bear at the apex a tuft of fibres (coma) which is two or three times the length of the seed. The embryo is straight and lies in the longitudinal axis of the seed, its cotyledons slightly exceeding the length of the caulicle, which points to the apex. A rather thin endosperm surrounds the embryo. The seeds are very bitter and astringent, evident in a single specimen.

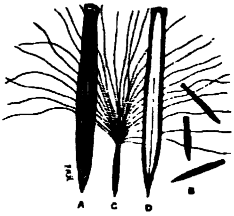

Fig 72.

Besides being scattered in the manner of the Milk-weed seeds, these might, under certain conditions, be distributed by some of the grass seeds.

Fig. 72.—Indian Hemp, *Apocynum cannabinum*. A, a seed, enlarged. B, a group showing the natural size. C, one bearing the tuft of fibres, natural size. D, a section taken lengthwise, showing the embryo and surrounding endosperm.

The COMMON MILK-WEED, or SILK-WEED, *Asclepias Syriaca* L., as a weed of roadsides and the borders of fields, is common in western Nevada, as elsewhere. Its light colored, coarse herbage, broad, opposite leaves, pink flowers and thick, rough seed vessels serve to distinguish this plant. It spreads locally by underground stems, so often occurs in small patches.

The *seeds* of *Asclepias Syriaca* are much flattened and narrowly egg-shaped, the smaller extremity (apex) truncate. Their length varies from one-fourth to five-sixteenths of an inch. A comparatively broad, distinct wing-margin surrounds the kernel-bearing portion of the seed. Its inner border is indicated by a distinct groove on each face. Both the kernel-bearing portion and the margin are evidently bi-convex. One face (the inner) of the seed bears a slender ridge (the raphe) extending from somewhat below the middle to the apex where it forms the narrow seed-scar. The surface may be lightly grooved on each side of this ridge, and is usually somewhat uneven or wrinkled on the wing-margin. The kernel-bearing portion bears some very fine, short ridges or points and is often wrinkled at its junction with the margin. The color is dull, light brown, often darker about the central ridge of the inner face and lighter upon the apex, which, when the seed is discharged from the seed vessel, bears a tuft of white fibres (coma) several times the length of the seed. Often, in drying, the seeds become longitudinally curved in the direction of the inner face. The straight, flattened embryo having somewhat longer cotyledons than caulicle, is surrounded by a thin endosperm. The caulicle points to the apex of the seed.

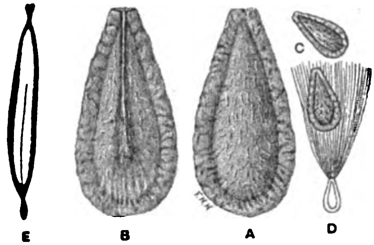

Fig. 73.

The lightness of these seeds and the size of their coma permit their being buoyed long distances on the wind. They are not apt to occur with commercial seeds.

Fig. 73.—Common Milk-weed, *Asclepias Syriaca*. The two faces of a seed shown at A and B, A the outer, and B the inner showing the raphe. C, two seeds, natural size. D, one, half size, showing the coma. E, a longitudinal section, showing the form and position of the embryo, and the endosperm.

Asclepias Mexicana Cav., is another Milk-weed as common in western Nevada as the preceding. It is slenderer, with several stems from the ground. The slender, recurved leaves are commonly in clusters of four each. The usually clustered seed vessels are slender and spindle-shaped.

The *seeds* are very similar to the others, but have thinner and narrower margins and are very dark reddish brown in color.

The BORAGE FAMILY contributes several plants of weedy character. The stiffish hairy herbage common to many of the plants of this family makes some of them, when dry, almost thistle-like in the severity of their prickliness. The ripened ovary splits into (usually) four very hard, seed-like nutlets each containing a single seed. In some instances, the nutlets are armed with barbed prickles giving them quite the nature of true burs.

The genus *Amsinckia* contains two weeds found in western Nevada. They are annual plants having simple leaves and small yellow flowers, the upper portion of the plant developing slender flower-clusters which are coiled at the end much as are the leaves of certain ferns. The dried herbage is very prickly and, in this respect, very disagreeable. The detached, seed-enclosing flower-calyx often acts as a bur, being carried by the hair of animals and by clothing. These plants are known as Yellow Bur-weed, Yellow Tar-weed and Fire-weed. Dr. E. W. Hilgard, in the Report of the Agricultural Experiment Stations of the University of California, for 1890, writes of these plants as follows: "Among the *Borraginaceæ* two native *Amsinckias* —*A. intermedia* and *lycopsoides* [*tessellata*]—are truly troublesome in the coast ranges, maintaining themselves on the heavier clay soils which they naturally occupy, despite of cultivation and to the material injury of grain crops, with which, in many seasons, they share the ground evenly or prevalently. From the clinging quality of their hooked, hirsute tomentum, the *Amsinckias* have received the inappropriate name of 'yellow tar-weed,' although entirely innocent of resinous qualities. [See under TAR-WEED, p. 61.] The nutlets accompany the bristly calyx on its migrations in the hair of cattle."

Amsinckia tessellata Gray, is the commoner of the two in the Truckee Valley. It grows singly and in dense patches in all situations, in spring. Its hardened, browned, fruiting stems stand till autumn, and when they occur in meadows must be very detrimental to the hay.

The *seeds* (nutlets) of *Amsinckia tessellata* are approximately one-eighth of an inch long. They are acutely and angularly egg-shaped, straight and considerably flattened. The surface is thickly set with small, rounded, wart-like tubercles which, when the intervening grooves are distinct, give the surface a tessellated appearance—whence the specific name of the plant. The outer, nearly plane face bears, furthermore, various transverse ridges or wrinkles, and has a faint, broad, central ridge lengthwise. The inner face is convex and bears the small, projecting, egg-shaped, sometimes slightly margined scar near the center. A narrowly ridged seam connects the scar with the pointed apex, and sometimes faint ridges join it and the angles of the base of the nutlet. The surface of the tubercles is smooth and sometimes glistens slightly. The color varies from light to dark brown. The embryo constitutes the kernel, there being no endosperm. Its general form is that of the nutlet, the short caulicle lying in the pointed apex of the latter. The fleshy cotyledons are peculiar in being deeply divided, the four half-cotyledons similar and nearly equal.

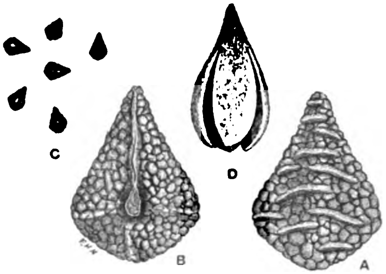

Fig. 74.

It is not impossible for these seeds to occur with commercial seeds of western production, but, at present, their distribution is chiefly local through their somewhat bur-like flower-calyxes.

Amsinckia intermedia F. & M., is usually slenderer than the preceding and has smaller flowers. Within the Truckee Valley, the plants are mostly scattered over the foothills and occasionally along roadsides. Their appearance in the hills indicates introduction by sheep.

The *seeds* (nutlets) of this species differ in form from those of the preceding in being very convex and somewhat curved in the direction of the inner face, resulting in their resting edgewise on a level surface. They are approximately one-eighth of an inch in length, though some scarcely exceed one-twelfth of an inch. The surface is very much roughened by projecting points or ridges, commonly by both. The outer face is acutely keeled lengthwise along the center.

Fig. 74.—*Amsinckia tessellata*. A and B, enlarged views of a nutlet; A, the outer face, and B, the inner face showing the scar. C, a group showing the natural size. D, the embryo, enlarged, in the same relative position as A and B. This shows the peculiar, divided cotyledons nearly edgewise.

often by a thin ridge or row of spine-like points. The sloping surface on each side of this ridge is thickly set with points or bears a variable number of irregular ridges extending to the edges which are thus more or less jagged. The inner face is similar with less uniformity in the arrangement of the ridges. This face bears the conspicuous scar near the center of the broad base. It is elevated, nearly circular, convex and narrowly margined. A broad, fold-like, elevated seam extends from the scar to the narrow apex, and narrow ridges often connect the scar and angles of the base. The color varies from light to dark brown, the scar lighter, and the more prominent surface points and ridges often whitish. The embryo is similar to that of ***Amsinckia tessellata.***

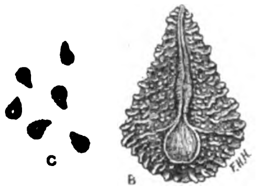

Fig. 75.

Echinospermum Redowskii Lehm., is a plant which occasionally assumes a weed-like tendency in western Nevada and eastern California. It is a slender plant very similar to the eastern weed, ***Echinospermum Lapula*** (***Lapula Lapula***), popularly known as Stick-seed and Bur-seed.

The *seeds* (nutlets) are acutely egg-shaped and are commonly about one-twelfth of an inch in length, though somewhat variable in this respect. The outer face has a somewhat flattened portion margined by a ridge bearing a single row of usually twelve or fourteen strong, barbed prickles. The latter are normally straight and radiate from the surface. The slenderer ones are clearly distinct, the

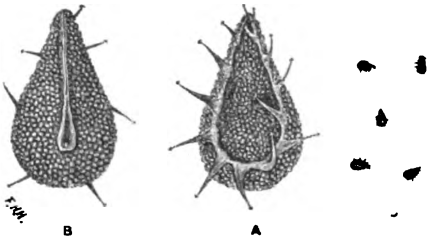

Fig. 76.

Fig. 75.—***Amsinckia intermedia.*** A and B, the outer and inner faces, respectively, of a nutlet. C, a group showing the natural size, (lying edgewise, owing to their convexity and curved form). The form of the embryo is shown at D, Fig. 74.

Fig. 76.—A Stick-seed, ***Echinospermum Redowskii.*** A and B, the two faces of a nutlet; A, the outer face bearing the prickles, and B, the inner face bearing the slender scar, enlarged. C, a group showing the natural size.

broader ones sometimes slightly connected between the bases. The prickles diminish in size towards the pointed apex of the nutlet, the length of the larger ones about equalling half the width of its base. Each prickle is tipped by a barb consisting usually of three or four hooks. The narrow, elevated scar is near the center of the inner face. A narrow, ridged seam connects its pointed extremity with the apex of the nutlet. The surface is dull and coarsely granular-roughened by small, thickly set, rough and whitish tubercles. The general color is light brown, or grayish under the lens, the scar and the tips of the prickles lighter. The embryo is flattened, its broad cotyledons longer than the short caulicle.

These nutlets are as truly "Stick-seeds" as those of *Lappula Lappula* which differ from them in having the prickles in a double row or irregularly scattered over the back of the nutlet. Both are very detrimental burs in sheep pastures.

CORN GROMWELL, *Lithospermum arvense* L., is a plant very generally and well known, as may be inferred from its several popular names other than that given above, viz., Wheat-thief, Stone-seed, Red-root, Pigeon-weed and Puccoon. It grows from six to eighteen inches high and has slender leaves and small, white flowers. Prof. Shaw states that "Pigeon-weed is most troublesome in crops that mature early," as "winter wheat, rye and meadows." Dr. W. J. Beal, in Bulletin No. 72, 1891, Mich. Agricultural Experiment Station, states: "It is a great pest in wheat because of the room it occupies and because the hard stems mature and scatter seeds before the wheat is cut or while the harvester is cutting it."

The *seeds* (nutlets) very appropriately give rise to the plant's popular name Stone-seed, owing to their very stone-like consistency and appearance. They are approximately one and one-half sixteenths of an inch in length with some variation in size. In outline, they are very uniformly conical-egg-shaped and slightly curved. The base is obliquely flattened. The inner side bears a distinct, central ridge throughout its length. The outer, convex side has a similar ridge extending from the apex one-half or two-thirds the distance to the base. The scar is conspicuous in occupying the broad, obliquely flattened base. It consists of a broadly, three- or four-angled, smooth, convex area bordered by the slightly projecting edge of the lateral surface of the nutlet. The scar surface is further characterized by two minute, but usually distinct points—one just within the margin at the base of the ridge of the inner face, the other on the opposite side of the center of the scar from the first. These points are commonly light-colored. The surface of the nutlet is roughened by small tubercles, and ridges separating comparatively deep and usually longitudinal pits. The surface of the tubercles and ridges is smooth, more or less polished and often has a diffused luster under the lens. The scar is dull. The color is commonly gray, but varies from almost white to very dark brown. The straight, fleshy embryo having broad cotyledons and surrounded by the thin seed-coat, fills the interior of the nutlet.

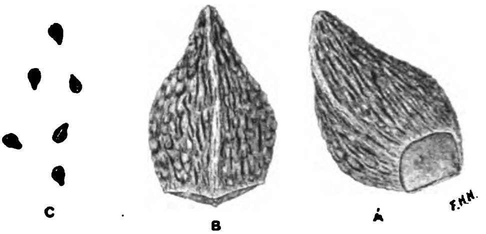

Fig. 77.

These seeds are apt to occur with those of the grains.

BLUE WEED, *Echium vulgare* L., is known also as Bugloss, Viper's Bugloss, Blue Devil and Blue Thistle. It is a prickly hairy plant growing from one to three feet high. The large, showy flowers are purplish at first and later become blue. It is a biennial, ripening its seeds the second year of its growth, when it is said to be "a very prolific seed producer." In many parts of the East, this is a persistent and dreaded weed.

The *seeds* (nutlets) of Blue-weed, like those of Corn Gromwell, are stone-like in the hardness of their protecting wall. They agree further with the others in size, the length being approximately one and one-half sixteenths of an inch. Whether the nutlets are straight or curved, the back of each is distinctly convex. The inner face is angled, sloping to the edges from a slender central ridge which extends from the pointed apex to the inner angle of the truncated base. A ridge along the center of the outer face extends from the apex midway to the base. The scar is a conspicuous, nearly plane, triangular area occupying the flattened base. It is acutely margined by the thin, slightly expanded,

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Fig. 77.—Corn Gromwell. *Lithospermum arvense*. A, and B, two views of a nutlet. A, an edgewise view of the back showing its partial ridge, and the scar. B shows the inner face with its central ridge, and the convex character of the scar. The position shown at A is that most commonly taken by the nutlet at rest. C, a group showing the natural size.

projecting edge of the lateral surface of the nutlet. The scar is also characterized by a small cavity at its inner angle, containing a projecting particle, and two projecting points near its center and in line with the lateral angles. The general surface is more or less roughened by various tubercles which, in some instances, are distinctly pointed. It is dull except along the ridge of the inner face, which is often somewhat polished. The color is usually gray or brown. The internal structure is essentially the same as that of Corn Gromwell.

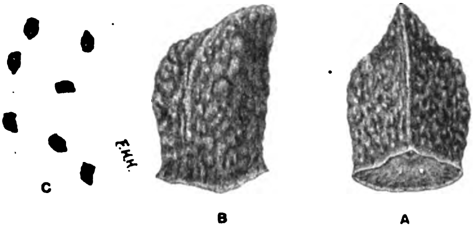

Fig 78.

These seeds, when occurring with commercial seeds are very apt to bear a part of the persistent flower-receptacle and calyx.

Convolvulus arvensis, L. is one of the Bind-weeds which infest field crops, often to a serious extent. (See Black Bind-weed, subsequently described). It grows in patches, and if the ground is otherwise unoccupied, it becomes thickly covered with the plant's trailing stems, and a carpet of showy, pinkish white flowers appears each morning to represent the only redeeming character of this weed. The stems of accompanying plants are encircled by those of the Bind-weed resulting in their retarded growth or their being borne to the ground.

A plant which is probably this species is becoming very common about Reno, Nevada, where it occurs chiefly along the borders of streets and in drives. Its very persistent, perennial habit has been admirably illustrated by a patch of plants which have noticeably thrived upon one of the University drives notwithstanding the frequent surface grubbing administered with some success to the associated summer weeds.

The *seeds* of this plant are rather large, approximating one-sixth of an inch in length. They are oval in form. One face is convex, the opposite, inner face sloping to the edges from a broad, central ridge. The portion of the face on each side of the ridge is plane or

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Fig. 78.—Blue-weed *Echium vulgare*. A, the inner face of a nutlet, showing the central ridge and the scar. B, an edge view, showing the back or outer face and its partial ridge, also the slightly expanded margin of the base. Both of these positions are commonly assumed by the nutlets when at rest. C, a group showing the natural size.

concave. A depression in the surface at one extremity of the inner face indicates the position of the scar. The surface is somewhat coarsely roughened and is dull throughout. The color is dark brown. The seed coats are thin and the large, yellowish embryo is surrounded by a thin coat of fleshy endosperm which, when the seeds are soaked in water, becomes mucilaginous. The broad, thin cotyledons are leaf-like and closely folded, one within the other.

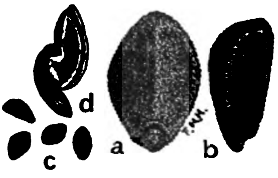

Fig. 79.

The seeds of this and another closely related Bind-weed (*Convolvulus sepium* L.) are very subject to distribution. Prof. Shaw says: "Bind-weed is generally distributed by means of the seeds of cereal grains, but it is also carried from place to place by the agency of water."

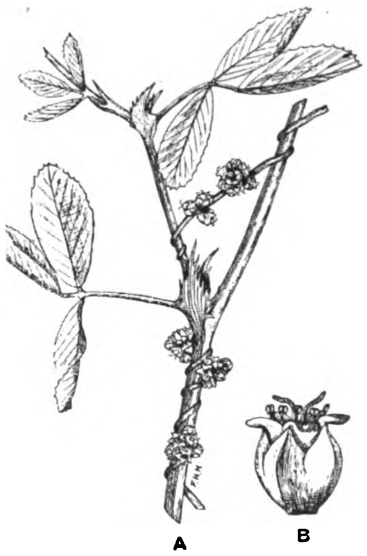

Fig. 80.

Dodder and Love-vine are the popular names by which several species of *Cuscuta* are known. These plants are peculiar in being parasitic in habit, thus depending for their subsistence upon food already prepared by other plants rather than upon that found in crude form in the soil. One kind of Dodder, *Cuscuta Epithymum* Murr., is a plant whose vital importance to the hay industry of Nevada perhaps exceeds that of the dreaded "Tickle-grass" (*Hordeum jubatum*). Many alfalfa fields within the Truckee Valley are nearly destroyed by this plant which has become common in many parts of the Valley since the publication from this department of Bulletin No. 15, 1892, which relates to this

Fig. 79.—Bind-weed. *Convolvulus*. **a**, the inner face of a seed showing the scar at the base **b**, an edge view of a seed. **c**, a group showing the natural size of the seeds. **d**. a side view of the embryo as it appears upon removal from the seed coats and endosperm.

Fig. 80.—Dodder, *Cuscuta Epithymum*. A, a portion of a stem of alfalfa encircled by a stem of Dodder bearing several clusters of flowers. B, an individual Dodder flower, much enlarged.

and two other kinds of Dodders. The presence of the plant in the field may be noted in the early part of the season by the tangled masses of reddish yellow, leafless stems which envelop the growing plants of alfalfa. Later, the globular clusters of whitish, often purple-tinged flowers attract attention and precede the production of an enormous number of seeds. In this region, this plant has a decided preference for alfalfa, which would seem to justify its denomination as Alfalfa Dodder. *Cuscuta Trifolii* Bab. which in Britton and Brown's Illustrated Flora is considered the same as *C. Epithymum*, is already well and unfavorably known in the East as Clover Dodder. Thus we probably have in this plant one of the most serious of weeds.

The *seeds* of *Cuscuta Epithymum* are minute, varying from one-thirtieth to one-twenty-fourth of an inch in diameter. Their form is oval or sub-spherical, the surface often somewhat flattened on the inner, scar-bearing side owing to compression during development. The scar is near one extremity of the longer specimens and is usually merely evident under the lens. The surface is dull and microscopically roughened. The color is various. It may be yellowish, light or dark brown, light green or strongly purplish tinged. The embryo is peculiar in possessing no cotyledons. Under the lens, it appears as a simple, slender, tapering body, thickest at the caulicle extremity. The presence of a few alternating scales at the smaller extremity is, seemingly, not readily evident under the simple lens. The position of the embryo in the seed is that of a spiral coil imbedded within the fleshy endosperm which becomes mucilaginous under the action of water.

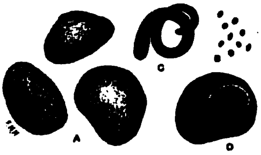

Fig. 81.

These seeds are widely distributed with those of clover and alfalfa and it is of the utmost importance that they should be detected and removed before seed containing them is sown.

The seeds of another Dodder, *Cuscuta arvensis* Beyrich, are very apt to occur with clover and alfalfa seeds grown in the East. Mr. L. H. Dewey states in Circular No. 14, 1898, of the Division of Botany, U. S. Department of Agriculture, that this is "the most injurious

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Fig. 81.—Dodder, *Cuscuta Epithymum*. A, a group of seeds, showing comparative form and relative size, enlarged. B, a group showing the natural size. C, the embryo, removed from the seed, showing the form it commonly assumes. D, a section of a seed, showing the manner in which the embryo lies imbedded in the endosperm.

native species east of the Mississippi Valley, and is found in less abundance in nearly all parts of the country farther west." Mention of the introduction of this species with alfalfa seed is made in Bulletin No. 15, p. 6, of the Nevada Agricultural Experiment Station. The plants from those seeds along with the entire plat of alfalfa which they infested were subsequently destroyed. Since then, plants of this species have been found in another part of the Truckee Valley.

The *seeds* of *Cuscuta arvensis* are larger than those of *C. Epithymum*, varying from one-twenty-fourth to one-sixteenth of an inch in diameter, and are usually more or less evidently notched at the scar near one extremity of the longer specimens. Furthermore they tend to be slightly egg-shaped and flattened. Thus the form is often strikingly like that of the clover seeds. As in *Cuscuta Epithymum*, the color is variable, including yellowish, light or dark brown, green and a reddish tinge while the others are often purplish. The embryo is essentially like that of *Cuscuta Epithymum*, but commonly longer. The size of some of the seeds is approximately that of white clover seeds, but the larger ones are intermediate between those of white, and red clover.

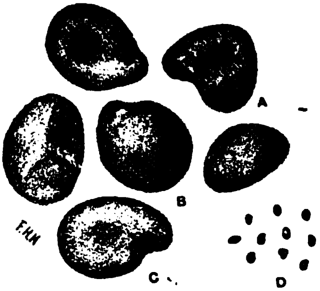

Fig. 82.

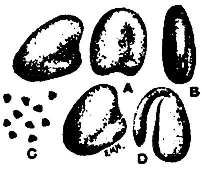

Fig. 83.

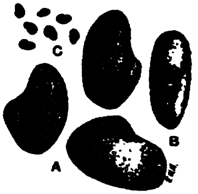

Fig. 84.

The surface of the seeds of both these species of Dodder is rough and dull while that of the clovers is smooth and

Fig. 82.—Dodder, *Cuscuta arvensis*; a group of seeds, enlarged, showing the prevailing forms. A, B and C, individual seeds having somewhat the form of clover seeds D, a group showing the natural size.

The figure was prepared with reference to showing without exaggeration the likeness of some of these seeds to those of clovers.

Fig. 83.—White Clover seeds. A, a group showing the form, side view. B, one, edge view, showing the scar. C, a group showing the natural size. D, the embryo.

Fig. 84.—Red Clover seeds. A, a group showing the form, side view B, one, edge view, showing the scar. C, a group showing the natural size

often has a slight, diffused reflection under the lens. The colors of the clovers are brighter, too. The scar of the Dodder seeds is almost indiscernable while that of the clover seeds is clearly evident within the marginal notch. While the size, form and color of the seeds of *Cuscuta arvensis* render it somewhat difficult to distinguish them without the aid of a lens, there should not be great difficulty in recognizing the seeds of *C. Epithymum*.

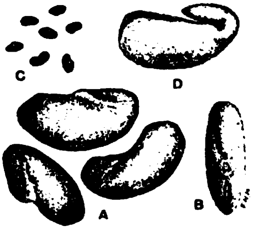

Fig. 85.

Black Nightshade, *Solanum nigrum* L., is an annual plant growing from a foot to two feet high. It has rather dense, dark green herbage. The somewhat egg-shaped leaves usually are toothed along the edges. The small, white flowers are clustered and are followed by green, spherical berries which become black as they ripen. Although the plant is very common, it does not have the aggressiveness of many weeds. However, it is a plant to be dreaded owing to the poisonous nature of its berries. Thus it should be prevented from growing where accessible to small children.

The *seeds* which resemble those of the garden pepper are much flattened with similar, slightly convex faces and rounded margin. They are approximately one-sixteenth of an inch in diameter and are circular-kidney-shaped or unsymmetrically egg-shaped in outline. The surface is finely granular, and dull. The color is yellowish or light brown. The slender, spirally coiled embryo is imbedded within the firm endosperm.

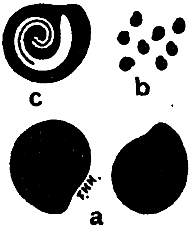

Fig. 86.

These seeds are normally retained within the dried and shriveled berries, so are little likely to occur individually among the commercial seeds.

Wild Tobacco, *Nicotiana attenuata* Torr., is a common western plant growing in both cultivated and neglected ground. Its upright

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Fig. 85.—Alfalfa seeds. A, a group showing the form, side view. B, one, edge view, showing the scar. C, a group showing the natural size. D, the embryo.

Fig. 86.—Black Nightshade, *Solanum nigrum*. **a**, two seeds, side view, enlarged. **b**, group showing the natural size. **c**, a section of a seed, parallel with the faces showing the spirally curved embryo imbedded in the endosperm.

habit, slender leaves, sticky surface and slender, white flowers distinguish it from other plants. Dr. E. W. Hilgard has written that its "viscous stems and foliage combine with an unpleasant odor to render it objectionable in the fields it invades."

The *seeds* are minute, approximately one-twenty-fifth of an inch in diameter. They are somewhat kidney-shaped and but slightly flattened. The surface is roughened by a comparatively coarse, star-shaped reticulation of very fine, sinuous ridges which radiate from the slightly projecting scar. The latter is situated on the concave edge between the center and one extremity. The color of mature seeds is dull brown, some having a slight reflection from the ridges. Immature seeds are amber-colored. The curved, cylindrical embryo has very small, accumbent cotyledons and is imbedded within an abundant endosperm.

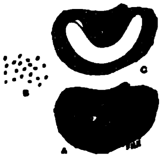
Fig. 87.

It is probable that these seeds do not often occur with the commercial seeds.

Two kinds of MULLEIN are widely known as weeds and the botanists of many states have listed them among those of local importance.

GREAT MULLEIN, WOOLLY MULLEIN, *Verbascum Thapsus* L., occurs in Nevada, and in a few situations within and near the Truckee Valley, it seems well established. Its occurrence along the railroads indicates the manner of its introduction. This is one of the coarsest of the weeds. Its stout stems bear thick, broad, woolly leaves and are crowned by one or more fruiting spikes which ripen a multitude of seeds. The plant is a biennial which would yield readily to well directed opposition.

MOTH MULLEIN, *Verbascum Blattaria* L., is not a plant of Nevada, so far as the writer is aware. It is slenderer than the preceding with smooth herbage and smaller leaves. Its seed-producing power is illustrated by an observation by Prof. Moses Craig, recorded in Bulletin No. 19, of the Oregon Agricultural Experiment Station. A plant examined bore ninety-five flowers and ninety-one seed vessels. Three of the latter averaged 330 seeds each. Assuming a like yield

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Fig. 87.—Wild Tobacco, *Nicotiana attenuata*. A, a side view of a seed, greatly enlarged. B, a group in which the seeds are shown somewhat smaller than their actual size. C, a section taken lengthwise through the center, showing the embryo imbedded in the endosperm.

for all the flowers of the plant, the total seed production amounted to 61,380.

The *seeds* of these two species of Mullein are so similar as to justify a common description. Indeed, they cannot be distinguished with certainty by means of the ordinary lens. They are minute, approximating one-twenty-fifth of an inch in length, those of *V. Blattaria* possibly averaging slightly larger than the others. The usual form is columnar, the lateral surface slightly angular and six-sided. The base is truncate or obliquely so and broader than the rounded apex;—thus they are somewhat thimble-shaped. The scar is in the center of the flattened base. Each of the six slightly flattened, lateral faces is deeply pitted, the five to seven pits of each forming a longitudinal row. The pits of adjacent rows alternate. The cross-ridges between the pits of a row are narrow and commonly once or twice grooved lengthwise; or, they are wholly wanting, making the seeds six-grooved lengthwise. Owing to the alternating positions of the pits of adjacent rows, the ridges between the grooves are usually wavy or zigzag. These two forms of surface markings are represented in the seeds of both species under consideration; but, in the ample material examined by the writer, the pitted surface seems to predominate in *Verbascum Blattaria*, while the grooved surface seems to be the more common in the seeds of *V. Thapsus*. All are dull and the color varies from light to very dark brown. The straight, slender embryo surrounded by ample endosperm lies in the longitudinal axis of the seed, its caulicle pointing to the narrow extremity, or apex of the latter.

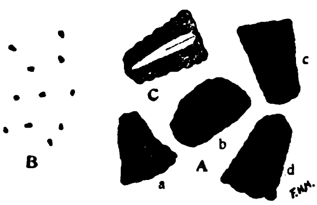

Fig. 88.

The frequency of occurrence of Mullein seeds among the commercial seeds is reported by various observers. Prof. A. D. Selby, in Bulletin No. 83, 1897, of the Ohio Agricultural Experiment Station, states: "Moth-mullen deserves to rank among the very worst weeds of timothy meadows, since the small, brown seeds are so common among the seeds of this grass as well as in clover seed." He says

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Fig. 88.—Mullein, *Verbascum*. A, a group of seeds, enlarged, showing different forms, and kinds of surface markings. **a**, **b** and **c** were produced from seeds of *V. Blattaria*, and **d** from *V. Thapsus*. B represents a group natural size. C, a section taken lengthwise through the center of a seed, showing the embryo and surrounding endosperm.

further of the seeds, "Very frequent in seeds of timothy and similar seeds of grasses."

TOAD FLAX, BUTTER-AND-EGGS, *Linaria Linaria* (L.) Karst., is termed also Yellow Toad Flax in distinction from other species of the same genus having flowers of other colors. Ramstead and Ranstead are other common names of this plant which seems to be a very aggressive weed in certain sections of the country. Its showy flowers have led to its cultivation as an ornamental plant, unfortunately for agricultural interests. It spreads by its winged seeds and also by its underground stems by means of which it forms patches of plants difficult to eradicate.

The *seeds* of Toad Flax consist in part, of a broad wing-margin which contributes much to their form and appearance. They are, including the wing, very thin, and circular-oval in outline. The size varies considerably, the length varying from one-sixteenth to one-twelfth of an inch. The edge of the wing is entire or wavy and bears a distinct notch (near one extremity in the longer specimens) which contains the scar. The wing is finely cross-veined, the veins most distinct along its outer margin. The compound microscope or even a very good lens shows these veins to be connected by numerous, very short ones. The width of the wing is from one-half to three-fourths that of the kernel-bearing portion of the seed which is bi-convex, each face roughened by a somewhat variable number of projecting points. (These are not white as in the seeds of *Spergula*, which might be inferred from the accompanying figure.) The general color is very dark brown or black accompanied by a slight, diffused, metalic luster evident under the lens. The slender, slightly curved embryo lies in the greater diameter of the seed and is surrounded by endosperm, its caulicle pointing to the scar in the wing.

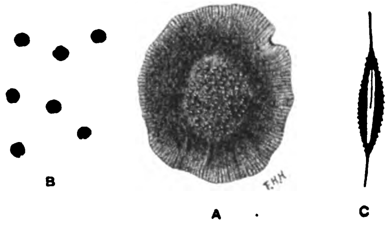

Fig 89.

These seeds are very apt to be distributed by the grass seeds. In

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Fig. 89.—Toad Flax. *Linaria Linaria*. A, a side view of a seed much enlarged, the scar within the notch on the upper right-hand margin. B, a group showing the natural size. C, a section through the center of a seed showing the embryo.

order that they should be well known to the farmers of Michigan, Dr. W. J. Beal accompanied Bulletin No. 72, 1891, of the Mich Agricultural Experiment Station by actual specimens along with the seeds of Canada Thistle, Rib-grass and a few other weeds.

The SPEEDWELLS are rather insignificant little plants of moist ground. They are not pernicious weeds but as a result of growing in damp meadows their seeds frequently occur among smaller grass seeds.

PURSLANE SPEEDWELL, or NECK-WEED, *Veronica perigrina*, L., is very common in Nevada.

The *seeds* are minute particles approximating one-thirty-second of an inch in length, although they vary somewhat in this respect as well as in form the latter being oblong-egg-shaped in well developed specimens. They are much flattened, often being slightly curved in the direction of the inner face. The outer face bears a slender, central ridge extending from the often slightly projecting scar at one extremity nearly to the other extremity. This contains the straight embryo surrounded by the endosperm. The inner face bears, in the corresponding position, a faint line (the raphe) terminating in a more distinct, sometimes elevated spot (the chalaza) situated somewhat beyond the center of the seed from the scar. The surface is microscopically roughened, and dull or with a slight, diffused reflection evident under the lens. The color is light or reddish yellow, the chalaza and scar commonly darker.

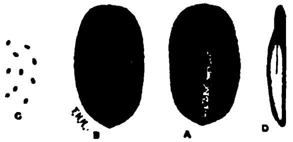

Fig. 90.

The seeds of *Veronica arvensis* L. and *V. officinalis* L, are so similar to those described as to be practically indistinguishable from them.

Several kinds of Vervain (*Verbena*) occur in cultivated land, meadows and pastures. One of these is BLUE VERVAIN, *Verbena hastata* L.

The *seeds* (nutlets) of Blue Vervain are slenderly oblong and considerably flattened. Average specimens are approximately one-twelfth of an inch in length with same variation in individuals. Their general,

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Fig. 90.—Purslane Speedwell, *Veronica perigrina*. A and B, the outer and inner faces respectively, of a seed. C, a group showing the natural size. D, a section of a seed, lengthwise, showing the embryo.

structural appearance is very constant. Each is bordered throughout by a narrow margin evident on both faces. The outer face is convex and bears three or five more or less distinct ridges lengthwise. At one extremity (the base) of the nutlet these are separate from each other; and, above the middle of the nutlet, they branch and unite forming a coarse but indistinct network. The inner face slopes to the margin from a central, longitudinal ridge. The scar is a slightly elevated, spongy portion of tissue at the base of the nutlet on the inner face and just within the margin. The surface is nearly smooth and dull. The color is reddish brown excepting the light colored scar and often the adjacent margin. The nutlets are often somewhat scurfy due to the presence of some whitish scales. The straight embryo lies in the longitudinal axis of the nutlet, its caulicle pointing to the base of the latter. It is surrounded by a thin endosperm.

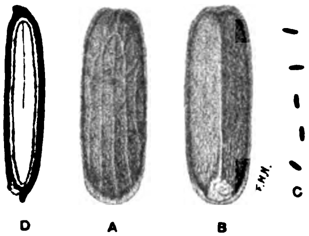

Fig. 91.

These seeds are common among the grass seeds.

The MINT FAMILY, *Labiatæ*, contains several weeds. The plants possess various characters of family significance, some of them being strongly scented. The seeds are permanently invested separately by the firm wall of sections of the ripened ovary, termed nutlets, in the same manner as in the Borage Family (See p. 78). The nutlets of *Brunella* develop a mucilaginous coat in the presence of water.

Of the several kinds of wild Mint, two are common in Nevada. One of these, SPEARMINT, *Mentha viridis* L., grows in dense patches along irrigation ditches and damp roadsides. It has dark herbage and its small, purplish flowers are clustered at the tips of the stems and branches. It multiplies profusely by underground stems. In this region, at least, it rarely produces seeds, the writer having many times looked in vain for them both in different years and in different localities.

Another Mint, *Mentha Canadensis* L., which seems to have no distinguishing popular name, is more generally common in the fields of

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Fig 91.—Blue Vervain, *Verbena hastata*. A, the outer face and B, the inner face of a nutlet. The latter shows the whitish, spongy scar at the base. C, a group showing the natural size. D, a section of a nutlet, taken lengthwise through the ridge of the inner face. It shows the position of the embryo. The nutlets of *Verbena urticifolia* L. differ from these in being wider and thus more robust.

western Nevada than the preceding. Its compact flower-clusters are in the axils of the upper leaves. It does not grow in dense patches, but scattered plants occur in all damp situations owing to the transportation of its abundant seeds by water. Both of these kinds of Mint are strongly scented.

The *seeds* (nutlets) of *Mentha Canadensis* are minute, oval-oblong and not flattened laterally other than slightly and partially so due to compression during development. The conspicuous scar occupies the base of the nutlet and is rounded or more commonly three-angled and light colored. The remaining dome-shaped part of the nutlet is very finely roughened and longitudinally striate, light brown and dull. The color is apt to vary to reddish brown. The size varies from one-twenty-fourth to one-fortieth of an inch in length, and there is also some variation in the general form. The kernel is without endosperm, the fleshy embryo filling the coats of seed and nutlet.

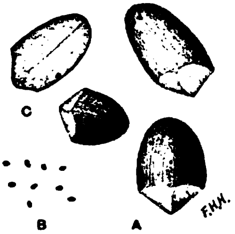

Fig. 92.

The habit of growth of this plant would naturally permit the occurrence of its seeds among those of grasses.

Nutlets from Scandinavian specimens of *Mentha viridis* received through the courtesy of Mr. L. H. Dewey, of the U. S. Department of Agriculture, differ from those of *Mentha Canadensis* only in their darker, reddish brown color.

CAT-MINT, or CATNIP, *Nepeta Cataria* L., so familiar to residents of the eastern States, occurs in several places in the Truckee Valley and doubtless in other parts of the State.

The *seeds* (nutlets) of *Nepeta Cataria* are somewhat flattened, oval bodies approximately one-sixteenth of an inch long with some variation in size. The surface is smooth or minutely roughened and dull. The outer face is uniformly convex, curved to the broadly rounded edge of the nutlet. The inner face is slightly compressed on each side of the longitudinal center. Near the base of this face is a pair of laterally placed cavities each filled with a pure white or yellowish particle of spongy tissue. These belong to the scar of the nutlet which

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Fig. 92.—Mint, *Mentha Canadensis*. A, three forms and comparative sizes of nutlets, enlarged. B, a group showing the natural size. C, a longitudinal section of a nutlet showing the embryo, its thick cotyledons nearly filling the interior.

occupies the remaining portion of the base of this face. The color is light brown, reddish or very dark brown, or nearly black. The base of the nutlet is usually darkest. Mature nutlets commonly have the thin, external wall broken away about the scar, exposing the dull, lighter brown seed proper. A slight, transverse depression in the surface of the seed, contains two pits corresponding to those of the outer wall. Occasionally, one or both of the white particles persist in the pits of the seed-coats. The straight embryo having relatively large, fleshy cotyledons which are parallel with the two faces of the nutlet, constitute the kernel, there being no endosperm.

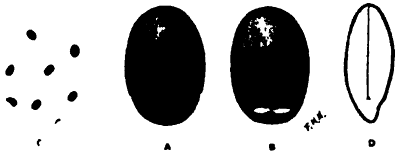

Fig. 93.

Catnip seeds are common among clover and other commercial seeds.

HEAL-ALL, or SELF-HEAL, *Brunella vulgaris* L., is a low, purple-flowered plant of meadows, pastures and similar situations, "across the continent." It is not common in the Truckee Valley, but is occasionally found along the margins of irrigation ditches.

The *seeds* (nutlets) of Heal-all vary in size from one-sixteenth to one-twelfth of an inch in length exclusive of the scar-appendage. They are flattened with both faces convex, the inner somewhat the more so. The form is oblong-oval, the base tapering to the very characteristic, small, whitish, triangular scar-appendage. The latter is rounded on the back and grooved on the inner side. The faces are very similarly marked by fine ridges appearing as dark lines which follow the margins of each nearly to the extremities where they curve and are parallel along the longitudinal center of each face. The surface and the lateral edges are evidently flattened between the lines. The general surface is microscopically roughened, and in fresh specimens has a slight, diffused luster. The color varies from light to dark brown, or is sometimes tinged with green. Blister-like spots on the surface give some specimens a mottled appearance. When placed in water, these

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Fig. 93.—Cat-mint, *Nepeta Cataria*. A, the inner surface of a nutlet, a part of the outer wall broken away about the scar exposing the seed and the two scar-pits at its base. B, the inner face of a nutlet, its wall entire and bearing the white scar-particles. C, a group indicating the natural size. D, a section lengthwise through the center showing the embryo.

nutlets develop at once or after prolonged soaking, a copious coat of milky white mucilage the thickness of which about equals half the width of the nutlet. Upon drying, this usually remains as a light colored, filmy covering to the nutlet. The kernel is without endosperm, the cotyledons of the straight, fleshy embryo lying parallel with the faces of the nutlet.

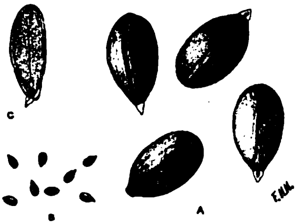

Fig. 94.

The seeds of Heal-all form a common ingredient of commercial seeds. In referring to this plant, Dr. Byron D. Halsted, in the Report of the Botanical Department of the N. J. Agricultural Experiment Station, for 1892, says: "It is no wonder that this plant is widespread, because of the ease with which its seed goes undetected in clover seed and the difficulty in separating it when found."

HOREHOUND, *Marrubium vulgare* L., is a tufted, white-woolly, rough-leaved plant very common about the sites of abandoned, early settlements of western Nevada. It is common throughout the East.

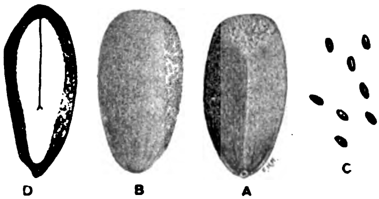

Fig. 95.

The *seeds* (nutlets) of Horehound are oblong-egg-shaped and somewhat flattened. They are approximately one-twelfth of an inch long with but little variation in size. Each is sufficiently flattened to present an outer and an inner face. The outer face is uniformly convex or sometimes slightly grooved at the base. The inner face is angled, the surface sloping to the edges from a central, longitudinal ridge which is terminated at the base by the small scar, and near the other extremity by the sloping surface of the apex. The edges of the nutlet about the scar are often slightly margined, and the surface lightly grooved. The margins and the central ridge of the inner face are

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Fig. 94.—Heal-all, *Brunella vulgaris*. A, a group of seeds, enlarged, the lower left-hand one with the scar-appendage broken away; the upper left-hand one showing the outer face. B, a group showing the natural size. C, a longitudinal section of a seed, showing the embryo; the inner face at the left.

Fig. 95.—Horehound, *Marrubium vulgare*. A and B, the inner and outer faces, respectively, of a nutlet, enlarged. C, a group showing the natural size. D, a longitudenal section showing the embryo and endosperm.

more acute in some specimens than in others. The surface is smooth and dull or sometimes finely roughened by numerous, minute tubercles. (The latter character is very evident in a quantity of Canadian specimens examined). The surface of the apex is usually more roughened than the remaining surface. Occasional, very smooth specimens have a faint, diffused luster. The color varies from gray to light or dark brown. The straight embryo is surrounded by a small quantity of endosperm.

Since the long-lived plants of Horehound are apt to persist in meadows and along their borders, its seeds are very likely to occur with those of clovers and some grasses. Indeed, the writer has, in several instances, found them among western grown clover seeds.

Dead Nettle, or Henbit, *Lamium amplexicaule* L., is a little round-leaved, purple-flowered plant of eastern fields and gardens, which does not seem to have found its way to Nevada as yet. It may do so, however, as its seeds occur with the commercial seeds. Dr. B. D. Halsted says* that it "is quite a troublesome pest in cultivated ground, seeding rapidly and constantly throughout the season."

"It is becoming very frequent in lawns and gardens, proving aggressive in both situations." †

The *seeds* (nutlets) of Dead Nettle are very similar to those of Horehound in their general form and vary from one-sixteenth to one-twelfth of an inch in length. The edges and central ridge of the inner face are more acute, however. The edges of some specimens, in which the lateral surfaces of the inner face are sightly concave, are narrowly margined above the base. The central ridge of the inner face is usually grooved toward the apex and very thin at the base. The scar constitutes a yellowish, spongy, tissue about the pointed base of the nutlet. The light brown, general color of the surface is conspicuously marked by whitish spots some of which coalesce making the surface partially striped crosswise. The surface is smooth aside from the very

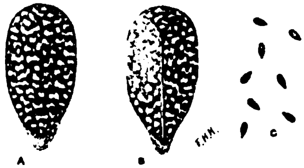

Fig. 96.

Fig. 96.—Dead Nettle, *Lamium amplexicaule*. A, and B, the outer and inner faces, respectively, of a nutlet. C, a group showing the natural size.

* Report, N. J. Agricultural Experiment Station, 1892.

† Prof. A. D. Selby, Bulletin No. 83, Ohio Agricultural Experiment Station, 1897.

slightly elevated, white spots which glisten faintly in fresh specimens. The straight embryo is surrounded by a thin endosperm.

These seeds occur to some extent in commercial seeds, and Prof. Selby says that they are "promising to become as omipresent as those of pepper-grass."

The PLANTAINS belong to the family *Plantaginaceæ*. They are perennial plants having insignificant flowers but which develop a great number of seeds. The plants are especially adapted for growth in meadows, pastures and lawns where they become very persistent when once established. The seeds of the especially weedy Plantains, which may be readily recognized, like many of those of the *Cruciferæ*, produce a copious coat of mucilage when immersed in water. The nearly straight embryo lies in the longitudinal axis of the seed and is surrounded by endosperm. Four kinds of Plantain are generally considered as noxious in character. The fact that nearly every kind of grass and clover seeds distribute one or another kind of Plantain, renders a knowledge of their seeds very important.

NARROW-LEAVED PLANTAIN, *Plantago lanceolata* L., has been discussed by many writers upon weeds and its wide distribution in this country and Europe has led to its acquisition of numerous other popular names, as English Plantain, Buckthorn Plantain, Rib-grass and Ripple-grass. Besides these, a dozen or more other names have been applied to it in the past. Its narrow leaves and slender flower-stalks stand a foot or more high and are readily detected in the lawn or meadow.

The *seeds* of Rib-grass are oblong, or sometimes slightly oval in form, and flattened. They vary in length from one-twelfth to one-eighth of an inch. The outer face is uniformly convex the rounded edges folded inwardly forming a rim about the deep, longitudinal groove of the inner face. At the basal extremity of the seed (that containing the caulicle of the embryo) the marginal rim of the inner face is open, the central groove thus extending to the profile margin. The seed-scar is an often dark colored spot in the center of this groove. The width of the groove is variable, sometimes very narrow. The embryo lies very near the surface of the outer face of the seed, and is slightly curved accumbently. The surface is nearly smooth with a diffused luster, or highly polished and shining. Occasional seeds show faintly, or even rather distinctly in some instances a slight, transverse groove across the convex face just below the center. This character is not so constant, however, as in the seeds of *P. aristata*, next described. The color is somewhat that of amber or brown. A slight translucency commonly permits the embryo being discerned through the wall of the convex face. Shriveled and blackened, sterile seeds occur frequently with the mature ones. The copious coat of mucilage produced in water, is transparent without an evident, white, inner layer as in the seeds of *Plantago aristata*.

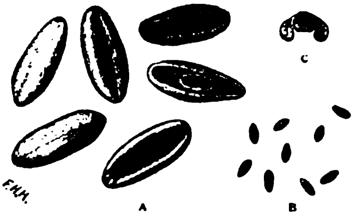

Fig. 97.

Innumerable instances of the occurrence of these seeds with the commercial seeds might be cited; but it may suffice to state that in recognition of the importance of a knowledge of these seeds, Dr. W. J. Beal has distributed samples of them with bulletins (Nos. 56 and 72) from the Michigan Agricultural Experiment Station.

BRACTED PLANTAIN, *Plantago aristata* Michx., has, within more recent years, become recognized as a weed. It has long been known in the East, but through the agency of commercial seeds, it has become widely scattered and in many places unduly common. Mr. L. H. Dewey states in Farmers' Bulletin No. 28, 1895, of the U. S. Department of Agriculture, that "after the first introduction, the bracted plantain grows in dense colonies, covering the ground so thickly as to choke out all other vegetation." Since this plant is an annual, it should yield to proper treatment much more readily than Rib-grass.

The *seeds* of *Plantago aristata* are oval-oblong and range from one-twelfth to one-eighth of an inch in length. Their general structure is much like that of the seeds of *Plantago lanceolata*. They are broader, however, as is also the groove or depressed portion of the inner face. The greatest width is often between the center and the base. The rounded, outer face is commonly

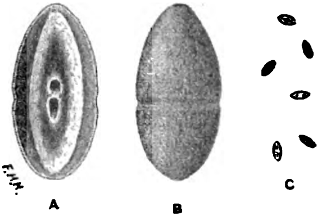

Fig. 98.

Fig. 97.—English Plantain, Rib-grass, *Plantago lanceolata*. A, a group of seeds, enlarged. The two at the left show the embryo through the outer face. The upper, right-hand one is a blackened, sterile seed. B, a group showing the natural size. C. is a cross-section of a seed through the scar

Fig. 98.—Bracted Plantain, *Plantago aristata*. A, the inner, and B, the outer face of a seed, enlarged. C, a group showing the natural size.

marked by a distinct, shallow, transverse groove at or very near the middle. A thin layer of mucilage-producing tissue envelops the seed making the edges of the inner face very acute and the marginal rim to appear as though beveled inwardly. This covering also obscures the opening in the marginal rim at the base of the seed, which is a Y-shaped slit, sometimes evident as a dark spot near the base of the convex face. The whitish markings of the inner face are due to the presence of this mucilage-tissue. The scar occupies the center of the inner face of the seed, appearing as two, adjacent, slightly unequal cavities lying in the longitudinal diameter of this face. The general surface is minutely granular and dull. The color varies from light to dark brown, the extreme, marginal edge usually lighter (evident on the concave face); and, the margin of the depressed portion of the inner face just within the rim, also the edges of the scar-cavities gray or whitish. The copious coat of mucilage presents a white, inner layer of fine fibers from the seed-coat which, while wet, have somewhat the appearance of the dried mucilage-fibres of Hare's-ear Mustard, (See Fig. 20, C, p. 26). Upon the removal of this mucilaginous coat, the true form of the seed becomes more evident.

Mr. Dewey notes the local distribution of these seeds by means of their dry, parachute-like floral organs. Grass and clover seeds are carrying them everywhere.

The name **Broad-leaved Plantain** has been applied to two very similar species of *Plantago*, *P. major* L., and *P. Rugelii* Dec. The former, at least, is widely known as a plant of door-yards. Both occur abundantly in fields. Their seeds are very common in commercial seeds, and though similar in form, may be readily recognized.

The *seeds* of *Plantago major* are very small or minute, varying in length from one-twenty-fourth to one-sixteenth of an inch. This variation in size is due to the exceedingly variable number of seeds produced by the flowers of different plants of this species. They are much flattened, with acute edges. The outer face is uniformly convex, the inner more or less angular and bearing the

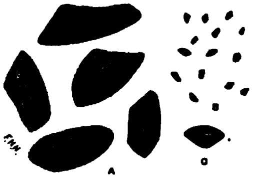

Fig. 99.

Fig. 99.—*Plantago major*. A, a group of seeds, enlarged, showing the relative form and size, also the surface ridges as dark lines. B, a group showing the natural size. C, a cross-section of a seed showing the position of the cotyledons of the embryo.

scar at the center. The outline of the seeds is variable, including oval, oblong, rhomboidal and trapezoidal. The surface is roughened by slender, colored ridges appearing under the lens as slightly wavy lines. These radiate from the scar, those leading to the extremities passing parallel to each other across the convex, outer face. In dark seeds, these lines are very indistinct but become clearer in the presence of water. Some of the seeds are slightly translucent. A very copious coat of transparent mucilage is formed in water, the whitish, fibrous, inner layer scarcely evident. The slender embryo is slightly curved incumbently. The color is light to dark brown, greenish or nearly black.

The *seeds* of *Plantago Rugelii* are, structurally, very similar to those of *P. major*, but are mostly larger, ranging in length from one-sixteenth to one-twelfth of an inch. The form is practically the same as that of the others, although many of them are comparatively thinner. The edges are very acute in some specimens, sometimes even forming a partial, narrow, translucent wing-margin. The scar is often very distinct at the center of the inner face. The color varies from dark brown to black, or is greenish. The surface is microscopically roughened and dull but wholly without ridges or lines as in *P. major*. The thick coat of mucilage formed by these seeds in water has a thin, but evident, white, inner layer immediately surrounding the seed-coats.

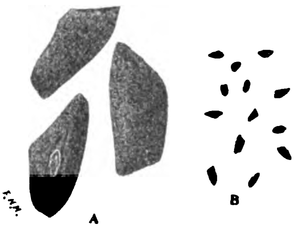

Fig. 100.

As already stated, these seeds are very common in the various commercial seeds.

The PIG-WEEDS, so-called, are represented by plants of two closely allied families, the Amaranth family and the Goosefoot family.

Those of the Amaranth family belong to the genus *Amaranthus* and are annual plants of gardens and cultivated fields everywhere. They produce an enormous quantity of seeds many of which are retained by the ripened plants till late in autumn or winter. The seeds are characterized in general by their very highly polished, shining surface, jet-black color, and circular or egg-shaped, and lens-shaped form. The scar is represented by a slight notch in the rather acute margin,

Fig. 100.—*Plantago Rugelii*. A, a group of seeds, enlarged, the lower one showing the scar. B, a group showing the natural size.

near the smaller extremity of the longer specimens. The two convex faces of the seeds are alike. Just within the edge is a narrow, slightly concave band the surface of which is microscopically granular-roughened as indicated under the lens by the rather diffused reflection. The slender, cylindrical embryo is curved forming a complete ring about the endosperm. Immature Amaranth seeds are reddish brown in color and often somewhat shriveled.

The seeds of the several kinds of Amaranth are very common in the commercial seeds, where they usually occur, often as broken pieces, near the bottom of the package owing to their size and weight.

Four kinds of Pig-weed are very common pests in Nevada while another kind, Spiny Amaranth, is a troublesome weed in the East and South.

Rough Pig-weed, *Amaranthus retroflexus* L., widely known, sometimes as Red-root and Careless-weed, and another kind, *Amaranthus chlorostachys* L., may be considered together since they are identical in general habit, very similar in appearance and, in Nevada at least, equally common. They are upright, slender or branched plants differing most evidenty in the thicker and shorter flower- and fruit-spikes, and rougher herbage of the former.

The *seeds* of these two Pig-weeds are indistinguishable under the lens. They are egg-shaped, sometimes narrowly so. The size is approximately one-twenty-fourth of an inch in length, those of *A. chlorostachys*, at least, being somewhat variable in this respect. A minute, projecting point beside the scar-notch is usually evident and sometimes separates the latter from an evident, concave portion of the edge of the seed. A slight depression in each face, near the scar is commonly discernable.

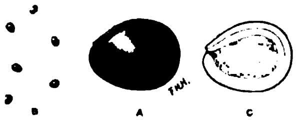

Fig. 101.

Spreading Amaranth, *Amaranthus blitoides* S. Watson, is a western Pig-weed which has become common in many sections of the East. It has prostrate stems which often form a thick mat on the ground.

The *seeds* of *Amaranthus blitoides* are the largest of those of the

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Fig. 101.—Rough Amaranth, Pig-weed, *Amaranthus retroflexus*. A, a side view of a seed, enlarged. B, a group showing the natural size. C, a section of a seed showing the relative positions of embryo and endosperm.
The figure serves equally well for the seeds of *Amaranthus chlorostachys*.

more weedy Amaranths. They are approximately one-sixteenth of an inch in diameter and vary in form from nearly circular to broadly egg-shaped. The faces are very uniformly convex. The size of these seeds and the character of growth of their plants should render them less common than the other kinds, in commercial seeds. The writer has, however, found them in western alfalfa seed.

Tumble-weed, *Amaranthus albus* L., is a low, much branched plant having light green herbage. Its flowers are scattered along the branches, their sharp-pointed bracts making the dried plants very prickly. In autumn, the stem breaks off at the surface of the ground and the plants are blown hither and thither scattering their seeds as they go, whence the plant's popular name.

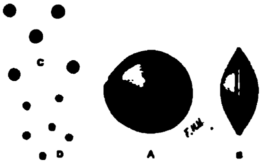

Fig. 102.

The *seeds* of Tumble-weed have very much the form of those of Spreading Amaranth. They are much smaller, however, varying from one-thirty-second to one-twenty-fourth of an inch in diameter. The larger specimens can scarcely be distinguished from some of those of *A. retroflexus* and *chlorostachys*. Each face is slightly depressed just within the scar.

These seeds are almost sure to occur among those of the meadow and lawn mixtures.

The Goosefoot Family, *Chenopodiaceæ*, contains several weeds among which are Lamb's-quarters, Winged Pig-weed and the notorious Russian Thistle.

Lamb's-quarters, *Chenopodium album* L., is often called Pig-weed and Goosefoot. It is a slender, much branched annual of gardens and cultivated fields wherever the Amaranths are found. Its seeds, like those of Dog's Fennel and Sheep's Sorrel are almost always present in certain commercial seeds.

The *seeds* of Lamb's-quarters are likely to occur in either of three different guises dependent upon the degree of their ripeness or the amount of threshing to which they have been subjected.

Fig. 102.—Spreading Amaranth, *Amaranthus blitoides* A, a side view of a seed; B, an edge view of the same; both enlarged. C, a group showing the natural size.

Tumble-weed, *Amaranthus albus*. D, a group of seeds, showing the natural size.

The internal structure of these seeds appears in Fig. 101, C.

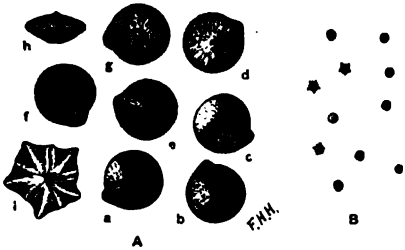

Fig. 103.

The seeds proper might very readily be mistaken for those of the Amaranths, owing to their general form and color. They are approximately one-twentieth of an inch in diameter. The form is nearly circular barring a rounded, marginal protuberance usually evident. In section, the seeds are somewhat lens-shaped, often rather unequally so owing to the fact that they are developed horizontally within the flower. The edge is bluntly rounded. The lower, more convex face bears a curved groove leading from one side of the marginal protuberance to near the center of the face (Fig. 103, a and b). This groove often contains the light colored scar-particle (Fig. 103. a). The surface is finely uneven, often with a faintly evident, radiating striation It is jet-black and has a diffused reflection or in some seeds is highly polished. The structure of the kernel is essentially the same as that of the Amaranths (See Fig. 101, C), the slender embryo being curved about the endosperm.

These seeds, as commonly occurring among the commercial seeds, are enveloped by the very thin, persistent and closely fitting wall of the seed-vessel which does not materially alter their size or form. This covering is finely granular and dull, and is gray, brown or black and sometimes radially banded by color. Its scar is represented by a spot or orifice at the center of the lower face (See Fig. 103, d and e). The corresponding position of the upper face usually exhibits the scar of the flower-style as a minute, projecting particle. Often, portions of this covering are broken away exposing the black, smoother surface of the seed proper; or the seeds may exhibit mere particles of it.

Furthermore, the coarser grass seeds often contain these seeds surrounded both by the seed-vessel and the floral envelop consisting of five angular, dull brown segments, which, together, have a somewhat star-shaped appearance (Fig. 103, i).

Fig. 103.—Lamb's-quarters, Pig-weed, *Chenopodium album*. A, a group of seeds showing different appearances. **a** and **b**, seeds proper, lower surface; **c**, the same, upper surface with persistent particle of seed-vessel; **d** and **e**, seeds enveloped by seed-vessel, lower surface; **g**, the same, upper surface; **h**, the same, edge view; **f** and **g** show the seed-vessel partially broken away; **i**, the floral envelop. B, a group of seeds, etc., showing the natural size.

As with the Amaranths, broken specimens of these seeds are often found among the commercial seeds.

WINGED PIG-WEED, *Cycloloma atriplicifolium* (Spreng.) Coulter, is a "tumble-weed" of the middle West ranging from the British possessions to Arizona.

The *seeds* of this plant, like those of Lamb's-quarters, are apt to present different appearances as the result of their being free from or associated with the dried floral organs. The seeds proper show relationship to Lamb's-quarters and the Amaranths in their general form, structure and color. They are approximately one-sixteenth of an inch in diameter, almost circular with a slight marginal notch relating to the scar, and somewhat unequally lens-shaped, the more convex on the lower face since they are developed horizontally. The edges are bluntly rounded. The lower face bears a slight, curved groove leading from the marginal notch nearly to the center. The upper face has a slight depression in the corresponding position. The surface is evidently granular and dull or with slight diffused reflection. The color is jet-back. The slender embryo forms a complete ring about the endosperm.

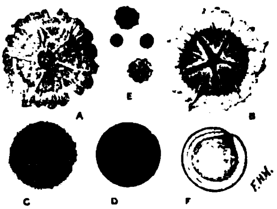

Fig. 104.

The seeds doubtless almost invariably remain invested by the very thin seed-vessel which cannot be removed while dry. It is so thin and transparent as to add only a gray tinge to the black of the contained seed. If it has not been subjected to severe rubbing, the surface is covered with a thin layer of tangled, whitish fibres.

Like the seeds of *Chenopodium album*, these are apt to be retained within the floral envelop forming an almost complete dried flower. This constitutes a lens-shaped body slightly larger than the seed proper and bordered by a thin, irregularly margined wing, the whole approximately one-eighth of an inch in diameter. The upper face of the flower exhibits the five lobes of the floral envelop (calyx), which are united just within the wing-margin, otherwise separated exposing

Fig. 104.—Winged Pig-weed, *Cycloloma atriplicifolium*. A and B, the lower and upper faces, respectively of a dried flower C, a seed-vessel exhibiting the covering of white fibres. D, the seed (lower surface), the thin seed-vessel having been removed after soaking in water. E, a group showing each of the preceding, natural size. F, a section of a seed showing the embryo and endosperm.

the black, often white-hairy seed-vessel in star-shaped form. The edges of the calyx-lobes are thin and light colored and each bears a central ridge extending to, and often upon the wing-margin. A minute, projecting point often present in the center of the seed-vessel indicates the remains of the flower-style. The wing-margin is usually more or less inclined toward the upper face. The lower face is convex. The scar is in the center commonly surrounded by a somewhat indistinct, ridged ring having five radiating ridges extending to the wing. The color of the dried flower is from light to dark brown. The seed-vessel is lightly held by the calyx-lobes but rather firmly held at its point of union with the calyx at its base.

The winged nature of the dried flowers of this plant gives rise to its popular name and doubtless aids materially in the local distribution of the seeds.

RUSSIAN THISTLE, *Salsola Kali tragus* Moq., has received more attention from recent writers upon weeds than any other plant of this country. So far as the writer is aware, this plant, known also as Russian Cactus and Russian Tumble-weed, is not found in the settled parts of Nevada. Our climatic conditions seem in every way adapted for its growth and were it to become established it might prove as destructive here as elsewhere. The plant is neither a thistle nor a cactus as its pouplar names would indicate. These names arise from the fact that the branches of the plant are clothed with rigid, sharp-pointed bracts which contribute much to the noxious properties of the plant.

The several quotations here employed are from Bulletin No. 15, 1894, by Lyster Hoxie Dewey, Division of Botany, U. S. Department of Agriculture.

The introductory paragraph is: " A weed new to America made its appearance a few years ago in the wheat-raising regions of the Northwest, and has already caused damage to the estimated amount of several millions of dollars. Spreading rapidly as it is over new territory and becoming more destructive in the region already infested, it threatens serious consequences unless prompt measures are taken to subdue it."

"The Russian thistle resembles the two common tumbleweeds of the plains (*Amaranthus albus* and *Cycloloma atriplicifolia*) [See pp. 102 and 104.] more than any other species found in America."

" A single plant of average size, two to three feet in diameter, and weighing two to three pounds at maturity when dry, is estimated to bear 20,000 to 30,000 seeds."

The *seeds* of Russian Thistle, like those of Lamb's-quarters and Winged Pig-weed, are distributed by the dried, floral envelop which structurally, is very much like that of Winged Pig-weed excepting that it consists of five separate calyx-segments each of which has a rounded, jagged-edged, wing-like lobe. The general form is more conical than in Winged Pig-weed. Each is about one-twelfth of an inch high and broad (See Fig. 105, B and C).

The seed proper is conical, the apex flattened or concave. The seed-coats form a very thin, nearly transparent membrane covering the embryo which constitutes the kernel, there being no endosperm. This membrane is finely wrinkled radially on the upper surface of the seed and usually shows the coiled nature of the embryo. The latter is very characteristic of this weed. It is long and slender when straightened. Within the seed, it is coiled in the form of a conic spiral (See Fig. 105, D and E). The caulicle tapers and the slender cotyledons are often, if not always, partially coiled separately. The light-colored seed and greenish embryo are each about one-sixteenth of an inch in diameter.

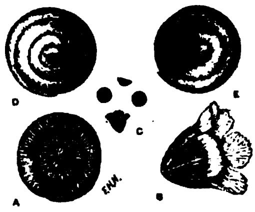

Fig. 105.

Mr. Dewey says: "The most important mode of distribution of the Russian Thistle, and the principal one furnished by nature, is the wind. In the winter when the ground is frozen, and especially when it is covered by dry, hard snow, the weeds are driven for miles by the strong wind, scattering seeds along their track, while gusts beat them about, covering with seed all the intermediate areas, and in blizzards, driving snowstorms and sandstorms, the seeds themselves are carried to some extent independently of the plant."

"The seed is also carried in barley and oats when these grains are not properly cleaned. It is said to have been found in wheat to some extent during the past year (1893)."

"The seed remains inclosed in the paper-like perianth, and together with this is loosely held in its place by numerous, twisted hairs so that it is not readily shaken loose from the plant * *. When

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Fig. 105.—Russian Thistle, *Salsola Kali tragus*. A, a seed, top view. B, a dried flower (perianth), as viewed edgewise. C, a group showing the natural size. D and E, the embryo; D, showing the lower side; and E, the upper side.

the seed breaks loose from the plant the paper-like flower parts surrounding it act as a sail, so that it may be carried a long distance over the snow independently of the rolling plant."

The weeds of the BUCKWHEAT FAMILY *Polygonaceæ* belong to the genera *Rumex* and *Polygonum*. *Rumex* contains the Docks, while *Polygonum* includes, among others, Knot-grass and Black Bind-weed.

The Docks, *Rumex*, are persistent meadow, pasture and wayside plants whose reddish, matured stems and seed-clusters often render them conspicuous intruders. The habit of growth of these plants results in their seeds being very common among the commercial seeds, one or more species being found in almost all of them.

The "*seeds*" of the Docks are seed-like, true akenes. They are three-angled with similar and equal faces (See Fig. 107, A and C), the angles obtuse or narrowly margined. The seed proper has the general form of the akene. The embryo is slender and lies incumbently curved along one face of the true seed and akene imbedded in the abundant endosperm. The floral envelop, or perianth often persists especially when these seeds occur with the coarser grass seeds. This consists of three variously formed, thin, veined segments the angles covered at the base by three smaller ones. Their presence often decides the identity of these seeds. The color is red or green.

SHEEP'S SORREL, *Rumex Acetosella* L., is known also as Red Sorrel and Sorrel. It is a slender little plant often very abundant on light soils. Nearly everyone is acquainted with the sour taste of its foliage.

Its *seeds* (akenes), without doubt, form the commonest weedy ingredient of clover, timothy and other similar seeds. Specimens both with and without the close-fitting, persistent perianth scales are common. The predominating condition is dependent upon the kind of seeds infested, the threshing and the degree of ripeness of the Sorrel seeds.

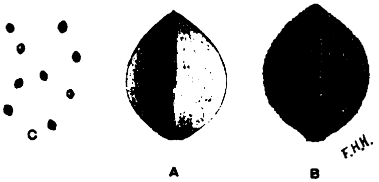

Fig. 106.

When invested by the perianth, these seeds are about one-twentieth of an inch in length with slight variation in size, grayish or red-

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Fig. 106.—Sheep's Sorrel, *Rumex Acetosella*. A, an akene, the perianth wholly removed; B, the same wholly covered by the perianth, the three outer segments evident at the base; both greatly enlarged. C, a group showing the natural size.

dish brown, finely roughened and dull. They are acutely elliptical or sometimes egg-shaped as they lie on one of the three equal faces. The angles are rather blunt and the scar of attachment is at the slightly projecting base, above which for one-third or one-half the distance to the apex the three outer segments of the perianth lie closely appressed to the angles of the seed. Each face of the latter bears a more or less distinct, central ridge with few lateral ridges, (the veins).

The perianth may be partially or wholly rubbed away exposing the akene proper. This is acutely elliptical with blunt edges and is but slightly smaller than the surrounding perianth. The faces are commonly not concave lengthwise. The surface is smooth with a diffused luster and is reddish brown or amber colored, the base and often slightly pointed apex darker, as are the edges near the apex.

Although very small, these seeds are soon readily recognized.

The *seeds* of other kinds of Dock commonly found with American commercial seeds are similar to each other but differ materially from those of Sheep's Sorrel in the appearance of both the akene and floral envelop, or perianth. (Compare Fig. 106–109.) The akenes are larger, more acutely pointed at the apex, at least, and are margined at the angles. The larger segments of the perainth are thin and winglike and have a fine, net-venation. One or all three have a conspicuous tubercle, or "grain" in the center. These segments are very characteristic in some species.

CURLED DOCK, or SOUR DOCK, *Rumex crispus* L., is a very general weed of meadows and pastures. Its narrow leaves are crisped along the edges and its red, matured stems and flower-clusters remain standing till broken down, as by snow. The strong, perennial root persists for years if not destroyed.

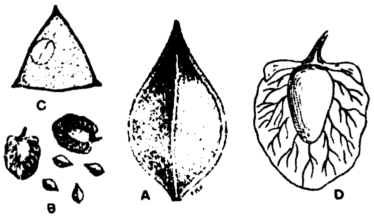

Fig. 107.

The *seeds* (akenes) of *Rumex crispus* vary in length from one-twelfth to one-eighth of an inch. They are acutely elliptical, usually

Fig. 107.—Curled or Sour Dock, *Rumex crispus*. A, an akene, edge view, as usually seen under the lens B, a group of akenes and matured flowers showing the natural size. C, a cross-section of an akene, at the middle, showing the form, edge margins, endosperm and embryo. D, a side view of a perianth segment, two of the three smaller ones leading from the stem.

with the apex the more slenderly pointed, the base abruptly contracted and pointed or sometimes scarcely so. Thus the greatest width is somewhat below the center of the seed. The angles are narrowly margined, essentially the same as in related species. The surface is smooth and has a distinct, diffused reflection. The color is very uniformly dark, distinctly reddish brown, the edges about the apex often darker.

The color and surface reflection aided by the form should serve to distinguish these seeds from those of the following kinds of Dock.

The larger segments of the often persistent perianth are obtusely heart-shaped. Each bears a distinct, obtuse tubercle but that of one segment is larger than those of the other two. The margins, if not torn, are slightly and irregularly toothed or entire and wavy.

BROAD-LEAVED DOCK, or BITTER DOCK, *Rumex obtusifolius* L., is similar to the preceding in habit and general appearance. It has broad leaves on slender leaf-stalks.

The *seeds* (akenes) are, structurally, similar to those of *R.crispus*. Their length varies from one-twelfth to one-eighth of an inch. They differ, however, from the others in being less abruptly rounded on the sides than many seeds of *R. crispus*, also in having a less evident contraction at the base above the scar. The surface affords but a faint, diffused luster and the color is light brown scarcely tinged with red.

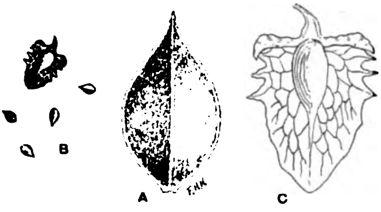

Fig. 108.

The larger perianth segments are narrower than those of *R. crispus* and bear about three pointed teeth on each edge near the base. The tubercle or "grain" of but one segment is developed. This tapers slenderly toward the tip of the segment. The average perianth is about three-sixteenths of an inch long.

WILLOW-LEAVED DOCK, *Rumex salicifolius* Weinm., is called also Pale Dock owing to the light green of its foliage, flowers and stems. The last are more commonly ascending than erect as in Curled and Broad-leaved Docks.

Fig. 108.—Broad-leaved Dock Bitter Dock, *Rumex abtusifolius*. A, an akene. C, a perianth, or mature flower. B, a group of the same, natural size.

The *seeds* (akenes) vary from one-sixteenth to one-twelfth of an inch in length. They are very acutely and often very broadly egg-shaped in outline, the base obtuse and usually not at all contracted at the scar. The thin edges are usually lighter colored than the light or sometimes dark reddish brown color of the faces of the akene. The surface has a diffused reflection. The faces are often slightly convex or concave and are sometimes lightly wrinkled at the base.

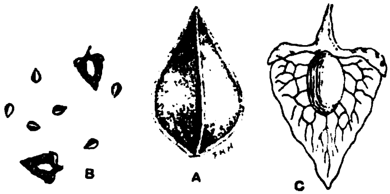

Fig. 109.

The perianth is about one-eighth of an inch long, the larger segments triangular-egg-shaped with about equal tubercles.

The *seeds* (akenes) of the KNOT-WEEDS, *Polygonum*, like those of Dock, have many structural and other characters in common. Some kinds are always three-angled, others always but two-angled and flattened, while still others have both forms represented. All the three-angled forms, among the commoner weeds, at least, tend to be less symmetrical than the akenes of *Rumex*. The embryo lies in one angle of the seed and akene near the base. The angles of the akene are not margined as in *Rumex*.

These seeds, as found among commercial seeds, are apt to be partially or wholly covered by the perianth, or have a part of it adhering at the base.

KNOT-GRASS, or DOOR-WEED, *Polygonum aviculare* L., is common all over the country as a weed of yards and drives. The thick, green mat of spreading stems it provides during summer turns to a reddish brown in autumn. Its seeds are rather common in various commercial seeds. Notwithstanding its popular name, the plant is in no sense a true grass.

The commoner forms of *seeds* (akenes) of Knot-grass are acutely egg-shaped in general although rather variable in form as well as in size which varies from one-twelfth to one-eighth of an inch in length. They are broadest near the base and are slightly curved to one side toward the acute or bluntly pointed apex. They are, (barring the

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Fig 109.—Willow-leaved Dock, Pale Dock, *Rumex salicifolius*. A, an akene. C, a view of the perianth. B, a group showing the natural size.

exception subsequently noticed), unequally three-sided, the angles obtuse and the faces plane or sometimes concave lengthwise. The surface is finely granular and striated lengthwise. It is dull, or presents a slight diffused reflection under the lens, particularly on the edges. The color varies from light to dark reddish brown.

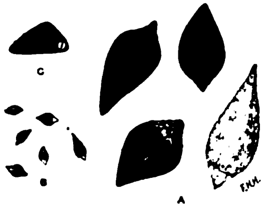

Fig. 110.

An exceptional form of these akenes (probably those of belated development) are slenderer and somewhat longer. The surface is smooth and often scarcely angled. The color is lighter brown than the others and the embryo is green.

All have a portion of the dull brown perianth usually persisting at the base, unless broken away in threshing. The embryo is slender throughout and incumbently curved.

Occasionally the seeds are covered with the five-parted perianth.

Black Bind-weed and Wild Buckwheat are the popular names of *Polygonum Convolvulus* L. This is a twining vine having arrow-head-like leaves. It is chiefly a pest of the cereal grains twining about their plants much in the manner of *Convolvulus arvensis* (p. 83).

The *seeds* (akenes) of Black Bind-weed are jet-black and rather equally three-sided. The outline is acutely elliptical, or egg-shaped and broadest near the abruptly pointed apex. They are approximately one-eighth of an inch in length. The base is obtuse and bears the scar. The faces are usually more or less concave, the angles being narrow and rounded. The surface is minutely granular, often with a faint, longitudinal striation, and dull except the angles which become polished and shining.

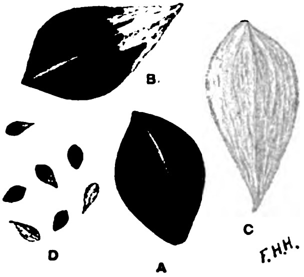

Fig. 111.

Fig. 110.—Knot-grass, *Polygonum aviculare*. A, a group of seeds, or akenes, showing the usual forms; and at the right, one of the smooth, light colored specimens. B, a group showing the natural size. C, a cross-section showing the relative positions of embryo and endosperm.

Fig. 111.—Black Bind-weed, *Polygonum Convolvulus*. A and B, views of two seeds, the latter bearing a portion of the perianth about the base. C, a view of an entire perianth covering a seed. D, a group showing the natural size.

As a frequent ingredient of grain seeds, mature Black Bind-weed seeds are usually wholly free from the perianth, or floral envelop. Under certain conditions, this may persist in part about the base of the akene; or wholly, giving the appearance of a light brown or green, sharply three-angled, tapering body.

SMART-WEED, *Polygonum Hydropiper* L., called also Water Pepper, is, as indicated by both popular and technical names, a plant of damp places. It grows in dense patches in a few places within the Truckee Valley. The painful, smarting sensation following the tasting of this plant is well known to many people.

Its *seeds* (akenes) are acutely and narrowly or broadly elliptical dependent upon the presence of three or two distinct angles. The apex is slenderly pointed and the base commonly bears a portion of the floral envelop. The length varies from one-eighth to one-sixth of an inch. Occasional specimens are equally three-sided with slightly concave faces, but they mostly vary from flattened and plano-convex, to unequally three-sided. The angles are blunt and the surface is minutely granular and not striate. The latter is dull or has a faint diffused luster evident under the lens. The color varies from light to dark reddish brown, the acute apex tip commonly lighter. The cotyledons of the accumbently curved embryo are flattened.

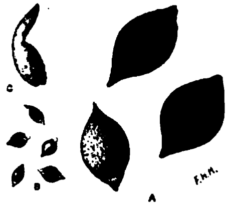

Fig. 112.

The smaller seeds of this kind are apt to occur with the grass seeds.

LADY'S THUMB, *Polygonum Persicaria* L., finds its most congenial surroundings in damp places; and, as it is a very widely distributed plant, growing almost wherever the proper conditions are found, its seeds very frequently become associated with the commercial seeds, of both clovers and grasses.

The *seeds* (akenes) of this species are much flattened and lens-shaped or with one face plane, the other convex at the base, at least, (gibbous); or, distinctly three-angled, the three nearly equal faces deeply concave. The obtuse edges are faintly angled along the center. The slightly variable form is commonly circular-egg-shaped. The base

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Fig. 112.—Smart-weed, *Polygonum Hydropiper*. A, a group of akenes showing different forms. B, a group showing the natural size. D, the embryo.

is obtuse or may bear a projecting portion of the perianth at the scar. The apex is abruptly pointed and thinner than the base making a longitudinal section rather wedge-shaped. The size is somewhat variable, but average specimens are approximately one-twelfth of an inch in length. The surface is finely uneven, polished and shining. Mature specimens are jet-black, others often brownish. The close-fitting, segmented perianth is lightly veined and is pinkish or brown.

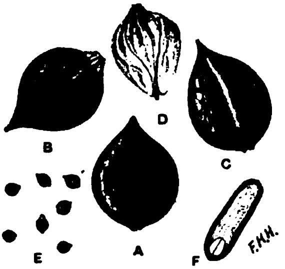

Fig. 113.

Owing to the size of these seeds and the upright growth of their plants in meadows, they probably form the commonest representative of *Polygonum* occurring in commercial seeds.

PALE PERSICARIA, *Polygonum lapathifolium* L., is very similar to the preceding in appearance and habit. It is not so common within the Truckee Valley, however, although in one field it has been found in abundance. It would seem to have been introduced recently.

The *seeds* (akenes) are flattened and are circular or oblong-egg-shaped in outline with abruptly pointed apex. The rounded edges are slightly angled along the center. The faces are concave, one of them sometimes bearing a faint, central ridge. The base is obtuse or may bear the projecting portion of the perianth about the scar. Including the latter, the usual length of the akenes is about one-eighth of an inch. The faintly uneven surface is polished and shining, and the color is dark, chestnut brown. The appearance of the perianth is essentially as in the preceding.

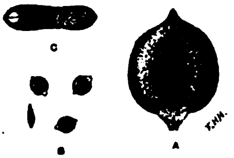

Fig. 114.

STINGING NETTLE, *Urtica dioica* L., is an occasional plant of western Nevada, growing along irrigation ditches and the margins of fields. It has a perennial root from which arise several stems having

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Fig. 113.—Lady's Thumb, ***Polygonum Persicaria***. A, B and C, side views of common forms of akenes; C, a three-angled specimen. D, one covered by the perianth (reduced from the size of A, B and C). E, a group showing the natural size. F, a cross-section of an akene.

Fig. 114.—Pale Persicaria, ***Polygonum lapathifolium***. A, a side view of an akene bearing a part of the perianth at the base, enlarged. B, a group showing the natural size, one shown edgewise. C, a cross-section of an akene.

slender, toothed and oppositely arranged leaves. Slender, drooping flower-clusters develop from the axils of the upper leaves. The stinging, prickly hairs of leaves and stems tend to make this plant well known where it is at all abundant.

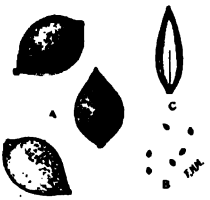

Fig. 115.

The *seeds* (akenes) of Stinging Nettle are very small and have little to characterize them. They are rather egg-shaped in outline and lens-shaped in section. The apex is acute and the base is slightly contracted at the scar. The approximate length is one-twenty-fourth of an inch with some variation in individuals. The two similar, convex faces are smooth, dull and light brown or sometimes whitish speckled. The edges are often faintly light or dark margined. The apex is commonly dark and sometimes may retain some of the fibres of the flower-stigma. The straight embryo has its caulicle within the apex of the seed and akene and is surrounded by a thin endosperm.

These seeds might easily occur with commercial seeds grown where nettle is abundant.

Two kinds of onion-like plants belonging to the genus *Zygadenus* of the Lily family are common in western Nevada and are included here because of their poisonous nature rather than any aggressiveness they may possess.

The plants are very similar except in respect to size and habits of growth. Fig. 116 gives a very good idea of the appearance of a young plant of either of these kinds. The lower half of the figure indicates the portion developed under-ground. The plants growing annually from a deep, onion-like bulb, have slender, scythe-shaped leaves surrounding one or more flower-stalks which bear clusters of yellowish white flowers.

Zygadenus paniculatus S. Watson, is the commoner in the vicinity of the Truckee Valley where it bears the popular names "Wild Sago" and "Sand Corn." It grows in the foot-hills in both sandy and rocky land. Its bulb is an inch or more in diameter and gives rise to rather coarse leaves each folded lengthwise in **V**-shaped form. Its flower-clusters are more or less branched.

Fig. 115.—Stinging Nettle, *Urtica dioica*. A, a group of akenes, enlarged. B, a group showing the natural size. C, a section of a seed and akene, engthwise, showing the straight embryo and surrounding endosperm.

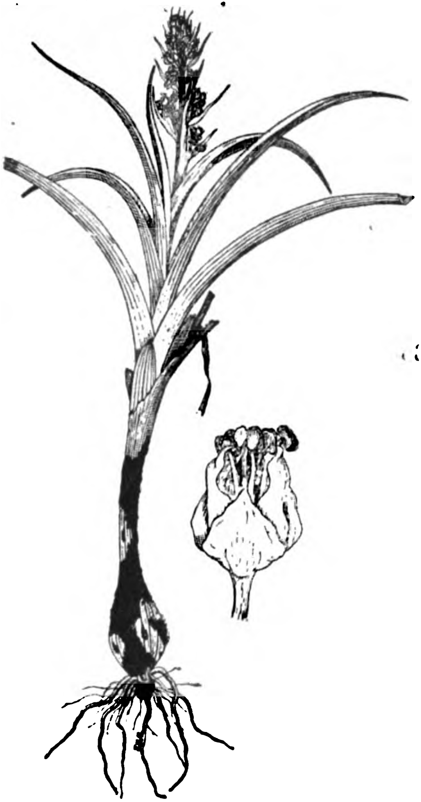

Fig. 116.

Zygadenus venenosus S. Watson, is slenderer, its bulb one-half or three-fourths of an inch in diameter and its flower-clusters simple or less branched than the others. It seems to confine its growth to the margins of streams and low, natural meadows, particularly those of saline character. It is known in California as "Hog's Potato" and by the Indians as "Death Camass."

Evidence of the poisonous effects of *Zygadenus paniculatus* has been recorded in two newspaper bulletins from this Department, (No. 5, May, 1893, and No. 21, April, 1897.)

The reported sickness of a horse, due to the presence of the seeds in hay leads to their illustration and description.

The *seeds* of *Zygadenus paniculatus* are oblong-spindle-shaped and vary from one-fourth to five-eighths of an inch in length. Usually, one extremity is pointed while the other is more or less flattened. The surface is variously compressed and angled. It is smooth with a distinct and diffused luster. A central cavity in the endosperm contains the small, slender embryo. The seeds have

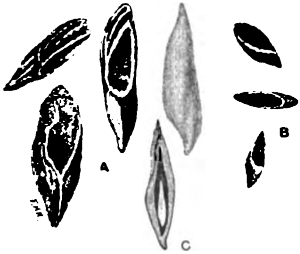

Fig. 117.

Fig. 116. —*Zygadenus paniculatus*; a plant produced from an old bulb, as it appears at an early stage of growth; also a flower, the latter greatly enlarged.

Fig. 117.—*Zygadenus paniculatus*. A, a group of seeds, enlarged. B, showing the natural size. C, a longitudinal section showing the embryo and endosperm.

a somewhat pungent taste accompanied by a rather persistent sensation of numbness.

The seeds of *Zygadenus* are not likely to occur with commercial seeds but may, especially those of *Z. venenosus*, be retained by hay where the plants are abundant.

Along with the seeds of more pernicious weeds occurring with the commercial seeds, are those of Sedges and Rushes. These plants which are usually passive in character, prefer damp or wet ground for their best development. Thus they usually may be controlled by proper drainage.

The *seeds* of the Sedges (*Carex*) are true akenes loosely enveloped by a sac-like covering. Both vary much in form, a fact of important significance in the classification of these plants. At A, Fig. 118, is shown a side view of an akene of *Carex* which is very common in commercial seeds. It is lens-shaped in section. The pointed appendage at the apex, (the persistent base of the flower-style) is often broken away by threshing. The smooth surface is commonly dull and varies from light to dark brown in color. The usual length is approximately one-sixteenth of an inch.

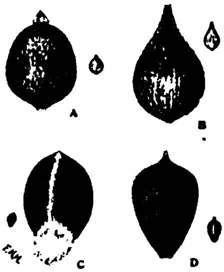

Fig. 118.

At B, of the same figure, is shown a side view of the enclosing sac (perigynium) of a common Sedge. It is plano-convex, smooth and light colored, greenish or dark colored. Its length varies from one-twelfth to one-eighth of an inch.

The seeds of various grasses, lawn and meadow mixtures exhibit these seeds in one form or the other.

The great family of GRASSES, *Gramineæ*, as compared with the other families of plants, has been said to be "the most important to mankind." However, besides its numerous plants of the highest value,

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Fig. 118—A and B, akene and perigynium, respectively, of a Sedge, *Carex*.
At C, Fig. 118, is shown a seed of a common Wood-rush, *Juncoides* (*Luzula*) *campestre* (L.) Kuntze. These seeds are globular-oblong and have a whitish, spongy appendage at the base, a whitish line often joining this and the opposite extremity along one side. The surface is microscopically roughened and rich, reddish brown in color. The length is one-sixteenth of an inch or less.
D, an akene of Bulrush, *Scirpus*.

there are many which, although possessing a low feeding value, grow persistently almost wherever agriculture is practiced. Such are classed with the weeds and a few of them are included in the present article.

The "*seed*" in grasses may be represented by the "grain" only, which contains the embryo; or, it may include the grain and more or less of the enveloping "chaff". The chaff consists of the dried scales (*glumes*) of the ripened flowers or flower-clusters. The clusters of individual flowers are termed *spikelets* each of which contains one or more flowers, *florets*. This term is here retained as referring to the ripened flowers. The lowermost scales of the spikelet are termed *empty glumes*. Each floret consists of a *flowering glume* and usually a smaller, included scale, the *palea*. These enclose the *grain* which may be *free*, i. e., not united to either; or, it may adhere to the palea at least. Thus, in the latter case, the grain does not readily separate from the chaff. Again, the free grain is often so firmly held by the rigid flowering glume and palea as not to separate from them. Hence the various guises in which the grass seeds may occur with the commercial seeds.

The degree of persistence of the several glumes, their form, comparative size, venation and other markings considered with the form, color and markings of the grain, constitute the principal characters by which the grass seeds may be recognized.

The PANIC GRASSES constitute the extensive genus *Panicum*, several species of which are recognized weeds. The single-seeded spikelets each have three empty glumes which may or may not persist.

BARNYARD GRASS, COCK'S-FOOT GRASS, *Panicum Crus-galli* L., grows everywhere in damp places. Forage value has been assigned to it, but it is, doubtless, best known as a weed.

Seeds.—The floret is plano-convex, the glume forming the arched convex face and the palea occupying the plane face, its edges covered by the edges of the glume. The outline is acutely oval and the length varies from one-twelfth to nearly one-eighth of an inch. The surface is smooth, highly polished and shining. The color is white, yellowish, gray or brown. Three light colored, longitudinal veins are more or less evident along the back of the glume, two others traversing the edges, one along each side. The two veins of the palea lie at the edges of the glume. The internal structure of both glume and palea give a minute, longitudinal striation.

Of the three empty glumes of the spikelet, the first is three-nerved and nearly one-half the length of the second and third. These are each five-nerved, nearly equal in length and cover the floret. The third glume is acute, as is the second, or tipped by a rigid awn varying from one-eighth to one-half an inch in length. These glumes are bristle-hairy on the veins and sometimes hairy on the remaining surface. The spikelets are straw-colored, greenish or purplish tinged. The grain is free but firmly held in the rigid floret. It is plano-convex and very similar to that of *Chamæraphis glauca* (See Fig. 121, E. and F.).

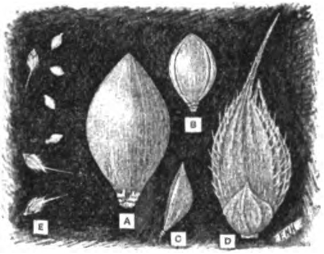

Fig. 119.

WITCH GRASS, *Panicum capillare* L., is as common as the preceding throughout the United States and in Canada. It is sometimes called Old Witch grass and Tickle-grass. It might very appropriately be called Tumble-grass since in autumn the stem breaks just below the seed-cluster which is then blown about often collecting in great drifts along fences and about buildings.

Seeds.—The florets are about one-sixteenth of an inch long, flattened and somewhat unequally biconvex, the back of the glume being the more convex. The outline is oval, the apex at least being rather acute. The surface is smooth, highly polished and shining. The general color is leaden gray, lighter at the extremities and along the edge of the glume. Five slender, light colored nerves join

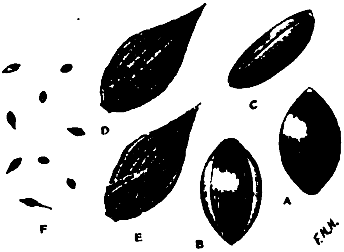

Fig. 120.

Fig. 119.—Barnyard grass, *Panicum Crus-galli*. A, a floret, back view of the glume. B, front view of floret, showing the palea. C, edge view of the same. D, the spikelet, showing the small first glume, the awned third glume and the tip of the second. E, a group showing the natural size of the preceding.

Fig. 120.—Witch grass, *Panicum capillare*. A, B and C, the outer, inner and edge views, respectively, of a floret. D and E are views of the spikelet; D showing the second glume and the first in part, and E the first and third and the second in part. F, a group showing the natural size of the preceding.

the extremities, crossing the back of the glume. Another crosses on each of the profile edges. The two light, longitudinal nerves of the palea are evident within the edges of the glume. Occasional florets are straw colored throughout. The florets separate completely from the empty glumes of the spikelet but may be wholly enclosed by them.

The first empty glume is three-nerved and from one-third to one-half the length of the spikelet. The second and third are similar, practically equal in length, acutely pointed and each seven-nerved. The spikelet is approximately one-twelfth of an inch long and is straw colored, brown or purplish.

The free grain is somewhat similar to that of *Chamæraphis viridis* (See Fig. 121, E and F.).

The FOX-TAIL GRASSES, *Chamæraphis*, formerly *Setaria*, are closely related to Hungarian grass, or millet. They are weeds of annual garden or field crops, which are to be recognized by their cylindrical, bristly heads. The spikelets are structurally very similar to those of the Panic grasses, to which they are closely allied.

YELLOW FOX-TAIL, or PIGEON GRASS, *Chamæraphis glauca* Kuntze, is very common in most parts of the United States but does not occur commonly within the Truckee Valley, and perhaps is not common in Nevada.

Seeds.—The tough, rigid floret is plano-convex, the glume strongly arched in the center and V-shaped in section. Its edges partially include the edges of the somewhat depressed palea. It is oval with blunt extremities, the apex often slightly three-toothed. The surface is characteristically roughened crosswise by very fine, more or less branching ridges. These are finer and somewhat less distinct across the palea. The surface is otherwise minutely granular and ordinarily dull. It is straw colored, yellowish or brown. The somewhat variable length averages about one-eighth of an inch.

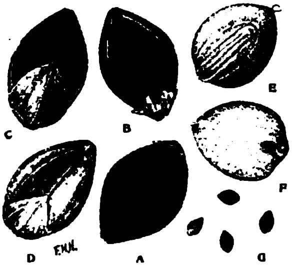

Fig. 121.

Fig. 121.—Yellow Fox-tail grass, *Chamæraphis* (*Setaria*) *glauca*. A and B, the outer and inner faces, respectively, of a floret; B, showing the palea. C and D, the same bearing the empty glumes of the spikelet; C, showing the second glume and the first and third in part; D, showing the first and third glumes and the second slightly. E and F, the grain; E, the convex, embryo-bearing face; and F, the plane face. G, a group showing the natural size.

The first of the three papery, empty glumes is three-nerved and nearly one-half the length of the floret. The second is plainly five-nerved and extends half way across the back of the flowering glume (Fig. 121, C.). The third is five-nerved, often concave, and nearly or quite equals and covers the floret (See Fig. 121, D.). An empty palea often occurs beneath the third empty glume. Persistent remnants of the empty glumes are often present about the base of the floret.

The free grain is oval or egg-shaped and plano-convex, the embryo resting on the convex face.

These seeds frequently occur with Hungarian grass seed.

GREEN FOX-TAIL GRASS, *Chamæraphis viridis* Porter, is very common as a summer weed of cultivated ground in Nevada as elsewhere.

Seeds.—The several parts of the ripened spikelet are structurally similar to those of Yellow Fox-tail. The floret is very similar to that of Hungarian grass. It is oval with blunt extremities, approximately one-twelfth of an inch long and somewhat unequally bi-convex, the back of the flowering glume being the more rounded. The general surface is granular and very faintly striate lengthwise and ridged crosswise the latter character being more evident in some specimens than in others. The edges of the palea are not granular but highly polished and shining. The general surface has a diffused luster. The color is commonly brown, although some specimens are gray and others white or yellowish. The darker ones are usually mottled.

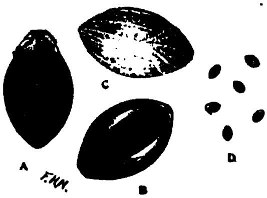

Fig. 122.

Of the three white, papery empty glumes, the first, or outer one is three-nerved and about half the length of the other two which are five-nerved, very similar and wholly cover the floret. The third glume is often slightly wrinkled at the tip on each side of the mid-nerve.

The grain is similar to that of Yellow Fox-tail except that it is bi-convex (See Fig. 121, E and F.).

Fig. 122.—Green Fox-tail grass, *Chamæraphis viridis*. A and B, views of the floret; A, the back of the glume and, B, showing the palea, its shining edges partially covered by the edges of the glume. C, a floret covered by the empty glumes (a spikelet), the figure showing the first and third glumes. D, a group showing the natural size.

The **Wild Oat**, *Avena fatua* L., is considered the ancestor of the cultivated oats. It is a weed of grain fields throughout the country, being particularly abundant on the Pacific Coast. Occasional plants are to be found within the Truckee Valley. It resembles he common oat in some respects but has large, drooping spikelets.

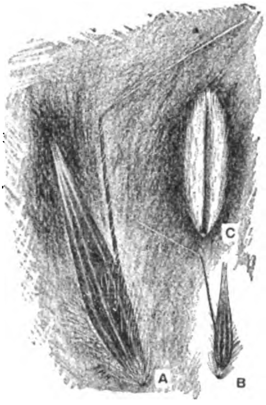

Fig. 123.

Seeds.—The florets each containing the free grain, are commonly distributed with the cereal grains. The glume is somewhat spindle-shaped and commonly about three-fourths of an inch long. There is some variation in the size of the florets of each spikelet, however, and the frail tip is often broken away in threshing thus reducing the length. The glume is rounded on the back and nine-nerved, the central nerve forming a twisted and bent awn which projects from near the middle of the glume. The awn which is bent near its center is often an inch or more long. The oblique, ring-like scar at the base of the floret bears a tuft of brownish hairs. The lower half of the surface of the glume is thinly hairy, the whole surface roughened by minute, upwardly directed bristle-points. The pointed, papery tip is deeply notched if not broken away by threshing. The grain is oblong, flattened and grooved along one side. It is about three-eighths of an inch long, pointed at the base and slightly hairy throughout, a tuft of hairs projecting from the apex.

Stink-grass, *Eragrostis major* Host., is a low, spreading grass of gardens in the latter part of summer and during autumn. Although it is an attractive grass, it is unpleasantly scented. Its bleached stems retain the dried seed-clusters till well into winter.

Seeds.—The grains alone may occur with commercial seeds since at maturity they freely separate from the enclosing glumes, or chaff. They are minute particles approximating one-

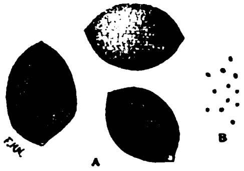

Fig. 124.

Fig. 123.—Wild Oat, *Avena fatua*. A, a floret, enlarged. (The figure is too dark.) B, one indicating the natural size. C, the grain, enlarged.

Fig. 124.—Stink-grass, *Eragrostis major*. A, three grains, enlarged. B, a group showing the natural size.

thirty-second of an inch in length. The form is circular-oval without being flattened. The extremities are slightly pointed and the embryo is represented by a slight ridge within a flattened portion of the surface at one extremity. A fine net work of dark lines is merely evident under a good lens. The color is dark red or wine color.

Eragrostis pectinacea (Michx.) Steud., is another grass of cultivated ground but differs from *E. major* in its upright habit of growth and fine flower-spray.

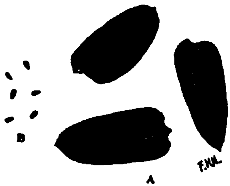

Fig. 125.

Seeds.—As in *Eragrostis major*, the grains alone would appear with the commercial seeds. These are larger than the others, approximating one-twenty-fourth of an inch in length; and, are oblong, the extremity opposite the embryo the narrower and point-tipped. The embryo ridge projects slightly from its rather blunt extremity and the surface network is slightly coarser. The reddish color is often very dark.

CHESS, or CHEAT, *Bromus secalinus* L., is a notorious pest of grain fields, which occasionally is to be found within the Truckee Valley.

Seeds.—The florets are approximately five-sixteenths of an inch long, rather turgid, tapering to the extremities, the glume rounded on the back. The inner face is concave including the palea. The section of the spikelet-axis (rachilla) is short and club-shaped, its scar being oblique. The glume is obscurely seven-nerved, the central nerve usually prolonged as a short awn projecting from the notched tip of the glume. The palea bears a row of spine-like hairs along each nerve. The floret is straw-colored.

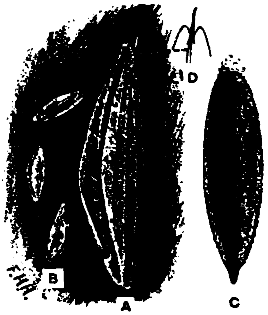

Fig. 126.

The grain is adherent to the palea and partially so to the glume. It is oblong, pointed at the base with a tuft of fibres at the apex.

Fig. 125.—*Eragrostis pectinacea.* A, grains enlarged. B, group showing the natural size.

Fig. 126.—Chess, Cheat, *Bromus secalinus.* A, a floret, enlarged. B, a group showing the natural size of the florets. C, a view of the grooved face of a grain, enlarged to the same scale as A. D, a diagram of the tip of the flowering glume.

and V-shaped, the surface next to the palea being grooved. Its color is reddish brown and it is approximately one-fourth of an inch long.

SQUIRREL-TAIL GRASS, *Hordeum jubatum* L., is known everywhere among the ranchmen of western Nevada as "Tickle-grass." Doubtless, it is the most generally dreaded pest of Nevada meadows. The plant is too well known to justify popular description.

Seeds.—These are distributed by the wind, probably very little if any by commercial seeds. The ripened seed-clusters break into sections (Fig. 127) each consisting of three spikelets of which the central one is fertile, the other two abortive. The fertile floret contains a slender, adherent grain. This floret is long-awned, the others short-awned. Each has a pair of slender awns representing the empty glumes. Thus each section of the seed-cluster is seven-awned, the awns about one and three-fourths inches long. Both the awns and the section of the cluster-axis are upwardly barbed permitting them to pierce the flesh in the mouths of stock eating this hay.

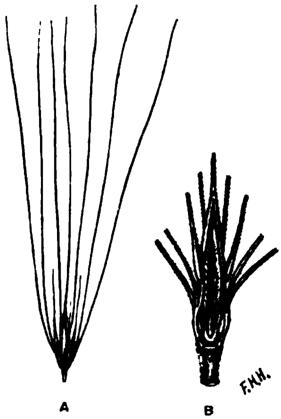

Fig. 127.

Fig. 127.—Squirrel-tail grass, Tickle-grass, *Hordeum jubatum*. A, a section of the seed-cluster, natural size. B, the lower portion of the same, enlarged. The fertile floret is in the center, the abortive ones on the sides. The awns are partially cut away.

ERRATA.

Page 4, sixth line from the bottom, for "seed" read seeds.
Page 57, fifth line, for "stems and" read brown.
Page 68, fifth line, for "consist of" read form.
Page 80, for "*Lapula*" read *Lappula*.
Page 91, for "*perigrina*" read *peregrina*.

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SOME NEVADA SOILS.

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NEVADA STATE UNIVERSITY.

Agricultural Experiment Station.

BULLETIN NO. 39.

RENO, NEVADA, DECEMBER, 1897.

Agricultural Experiment Station.

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THE DIRECTOR,
AGRICULTURAL EXPERIMENT STATION,
Reno, Washoe County, Nevada.

SOME NEVADA SOILS.

N. E. WILSON.

This bulletin is intended as a forerunner of a more exhaustive work on the soils and irrigation waters of the State of Nevada. A general survey of the State, for this purpose, is under consideration and it is hoped it can be carried out in the near future, for it is certain that such a survey would be of great benefit to our agricultural and horticultural interests.

As the purpose of this bulletin is to place before the farmers of Nevada information relative to that great storehouse of Nature from which they draw their rations annually, we prefix to our discussion of soils examined a statement of the origin, composition and general make-up of soils.

ROCKS.

The rocks which form the unbroken mass of the earth are, sometimes, formed from a single mineral, but usually contain several minerals in a state of more or less intimate mixture. Rocks naturally fall into three classes: *Igneous*, *Sedimentary* and *Metamorphic*.

IGNEOUS ROCKS Are those of igneous or volcanic origin, and whose present form is that assumed upon cooling down from the molten state.

SEDIMENTARY ROCKS Are those which have been deposited from water as sand, mud or gravel and which have become cemented and consolidated into solid rock. This name is also given to rocks of aqueous origin.

METAMORPHIC ROCKS have resulted from the alteration of aqueous sediments, or sedimentary, rocks by the action of heat without fusion. The original materials have thus been converted into new forms.

SOIL.

In its broadest sense, the term soil designates that portion of the earth's surface which has been formed by the disintegration of rocks and the decay of plants and animals, and which, under proper climatic conditions, is fit for the nourishment and growth of vegetation.

ORIGIN OF SOILS.

All soils are produced by the decomposition or disintegration of the original rock masses; for durable as rocks seem to be, they are not proof against the action of Nature's agencies, which are constantly at work tearing them apart and reducing them to fragments. Foremost among these agencies are water, air and frost. All rocks are more or less porous and consequently absorb water to quite an extent. During the winter seasons this water freezes, thus exerting a tremendous expansive force* which is sufficient and which does rend the rocks asunder. The rapidity with which this force acts is proportional to the porosity of the rocks and the severity of the frosts. Glacial action, by its grinding force, has been an important factor in soil formation. Many of the rocks contain compounds which readily unite with oxygen under ordinary conditions. This oxygen is abundant in the atmosphere, and the chemical change resulting from such combination causes rock fracture and crumbling. It then of course follows that a soil resembles in composition the rock from which it was formed, e. g., the disintegration of a sand stone and a lime stone will form soils which have the same characteristics as do the rocks themselves. Although this be true, soils possess many characteristics in common.

The term "soil" as commonly used, designates that portion of mineral matter and decayed vegetable matter in which plants grow. In distinction to this, that portion lying directly below the surface soil is known as the *subsoil*. In most cases this latter is separated from the former by a clearly defined change of color, the subsoil usually being much lighter in color as it contains less organic matter which has been acted upon chemically as has the humus of the surface soil.

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* In the act of conversion into ice, water expands 1-15 of its volume. S. W. Johnson H. C. F., p. 124.

KINDS OF SOIL.*

As regards mode of formation or deposition, soils are distinguished as *sedentary* and *transported.* The latter are subdivided into *drift*, *alluvial* and *colluvial.*

SEDENTARY SOILS, or soils in place, are those which have not been transported by geological agencies, but which remain where they were formed, covering, or contiguous to, the rocks from whose disintegration they originated. They are usually shallow soils.

TRANSPORTED SOILS are those which have been removed to a distance from the rock beds from which they originated by the action of moving ice (glaciers) or water (rivers) and deposited as *sediment* in their present positions.

DRIFT SOILS consist of fragments whose edges, at least, have been rounded by friction, if the fragments themselves are not altogether destitute of angles. They are usually deposited without any stratification or separation of parts. The materials consist of soil proper mingled with stones of all sizes from sand grains to immense rock-masses of many tons in weight. This kind of soil is readily distinguished from all others by the presence of the rounded rocks or boulders ("hard heads") it contains, and which are promiscuously scattered through it. The "drift" has undoubtedly been formed by moving ice in that period of the earth's history known as the "glacial epoch," a period when the present surface of the country was covered to a great depth by fields of ice.

ALLUVIAL SOILS consist of worn and rounded materials which have been transported by the agency of running water (rivers and tides). Since small and light particles are more readily sustained in a current of water than heavy masses, alluvium is always more or less *stratified* or arranged in distinct layers; stones or gravel at the bottom, and nearest the source of movement, finer stones, or finer gravel above and further down in the path of flow, sand and impalpable matters at the surface and at the point where the stream, before turbid from suspended matter, finally clears itself by a broad level course and slow progress.

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* Johnson's H. C. F., p. 143.

Alluvial deposits have been formed in all periods of the earth's history. Water trickling down a granite slope carries forward the kaolinite (a compound of silica and alumina hydrated, or containing water) arising from the decomposition of feldspar, and the first hollow gradually fills up with a bed of clay. Thus, in the valleys are deposited the gravel, sand and rock dust, brought from the neighboring mountains. Lakes and other bodies of water become filled with silt, carried into them by streams.

COLLUVIAL SOILS are those which, while consisting partly of drift or alluvium, also contain sharp, angular fragments of rock, from which they originally came, thus showing that they have not been transported to any distance, but are made up of soils in place, more or less mingled with alluvium.

ANOTHER CLASSIFICATION OF SOILS.

Soils are commonly spoken of, especially by the farmer, as *gravelly*, *sandy*, *clayey*, *loamey*, etc. This classification, while not of much scientific value, has its use for practical purposes.

GRAVELLY SOILS are so called from the large amount of small stones or pebbles in them. The name alone gives but a vague idea of the really important characters of the soil. Simple *gravel* is of small agricultural value; many highly gravelly soils are, however, very fertile. The fine portion gives them their crop-sustaining power, while the coarser parts insure drainage and store solar heat. The term *gravelly* admits of various qualifications. A soil may be very gravelly or moderately so, and the gravelly material may be coarse or fine, or may be slaty or granitic gravel, etc., according to its state of division or the character of the rock from which it was formed.

SANDY SOILS are those containing a large percentage (often 90 per cent or more) of sand. Sand often means quartz and there are areas of pure white quartz sand which are invariably barren, but in general, sandy soils are by no means free from other silicious minerals, especially feldspar and mica. Sandy soils often have a yellow or red color, due to oxides or silicates of iron, and point unmistakeably to the presence of ferruginous minerals or their decomposition products. These give quite a degree of fertility to such soils. The term sandy soil is obviously very indefinite and includes all extremes of fertility and barrenness, and a wide range in composition.

CLAYEY SOILS are those in which clay or impalpable matters predominate. They are usually of extreme fineness of texture and possess great retentive power for water. When dried they become cracked and rifted in all directions from the shrinking that takes place in the process.

LOAMY SOILS are those intermediate between sandy and clayey, and consist of mixtures of sand with clay, or of coarse with impalpable matters. They have none of the excessive tenacity of clay, nor the too great porosity of sand.

Beside these there are *calcareous* or *lime* soils, which are characterized by a preponderance of lime carbonate; *marls* or a mixture of fine clay and lime carbonate; *peat*, or swamp muck, etc.

COMPOSITION OF SOILS.

Soils consist chemically of two parts, *organic* and *inorganic*.

ORGANIC PORTION.—The organic portion is very complex and consists of decomposed and decomposing vegetable matter, worms, etc. Although all fertile soils contain some organic matter it is not essential to fertility that a given amount of it be present. It varies from 1.50 per cent to 50 per cent and may go as high as 70 per cent as is the case in peaty soils. A small portion of the organic matter is in the form of *humus*, a name given to the active principle of vegetable mould. To this humus is due the dark color of soils, and it is a very important soil constituent, inasmuch as it aids in providing nitrogen, an element very essential to plant growth; more than this, it influences the soils physically. "It gives them an increased moisture retaining power, makes them more responsive to solar heat and renders them more easy of tillage."

INORGANIC PORTION.—The inorganic or mineral portion of soils constitutes by far the greater part of their bulk and weight, and consists of a mixture of substances, all of which are found in the ashes of plants. Some of these substances act mechanically, giving soils the necessary bulk, porosity and water-holding power. Others act more directly by furnishing materials which the plant requires for growth. Agriculturally, the value of a soil depends upon the proportion of these substances present *in an available form.* A soil may contain an abundance of the elements of fertility yet be perfectly barren, for the simple reason that the materials or plant food are not in a soluble form so they can be assimilated by the plant through its roots and *rootlets.*

MINERAL SUBSTANCES PRESENT IN SOILS.

Silica, iron, alumina, lime, magnesia, soda, potash, phosphoric acid, sulphuric acid, chlorine, and sometimes manganese and fluorine, are present in all soils in varying proportions.

SILICA.—Forms the basis of most soils and is by far the most abundant solid constituent of the earth. It is present in soils in proportions varying from 29 per cent to 90 per cent, according to the character of the soil. In its usual insoluble form its action is merely mechanical. In most fertile soils a small amount of it is found in a soluble state, and as such it may enter the sap circulation of *plants.*

IRON.—Occurs in all soils as a finely diffused ferric hydrate. Its percentage varies from 1.50 per cent to 20 per cent, and it gives the color to red and yellowish soils. Though required in minute quantities, it is absolutely indispensible to plant life. Its function seems to be "giving the soil an increased power to absorb and retain heat and moisture, and rendering tillage easier in clay lands." As a plant food it it is supposed to aid in producing the *chlorophyll,* which gives the green color to plants.

ALUMINA.—The chief constituent of common clay. It does not directly contribute to the growth of plants, and is of but little value as a plant food. As clay, however, it is an essential constituent of soil; it has the property of absorbing and retaining *(fixation),* the easily soluble compounds of the soil, or those supplied to the soil by fertilization. Alumina varies in amount from one per cent to ten per cent, according to the kind of soil.

CALCIUM (lime).—An absolutely indispensible plant food, yet more important on account of its influence upon the mechanical condition of the soil, in the process of nitrification, and in the formation of soluble carbonates. It is one of the prime essentials of an arable soil; its absence in sufficient proportions is always followed by sterility. Lime is one of the most variable of soil constituents, existing in all proportions, from mere traces to as high as 30 per cent.

MAGNESIA.—Resembles lime in many respects, and generally accompanies it, as in dolomite, or magnesian limestone, present in all cultivated soils. "Of little importance as a plant food." —(Wiley). "Magnesia is absolutely indispensible to the plant." —(G. C. Caldwell). "An indispensible plant food."—(F. W. King). There is abundant evidence that it is needed for the complete development of our more common cereals. Its exact function as a plant food is unknown.

POTASSIUM.—Found in all soils and results from a decomposition of feldspathic rocks. It is an essential constituent of all plant food. As it occurs in soil it is very soluble, consequently is liable to loss through leaching. Ashes of plants contain potash in the proportion of from 10 per cent to 15 per cent.

SODIUM.—Is the basis of common salt and as such is everywhere abundant. It resembles potassium, but can in no sense take the place of potassium in plant nutrition, i. e., in land plants.

PHOSPHORIC ACID.—Occurs in all fertile soils, but usually in much smaller amounts than the other important ingredients. Never found free, but always combined either with iron, alumina, or lime. It is one of the soil ingredients most likely to be exhausted.

SULPHURIC ACID.—Is one of the constituents of most soils, present in minute quantities, usually combined with calcium in the form of gypsum.

CHLORINE.—Is usually associated with sodium in the form of common salt, which occurs in all soils and in natural waters. While chlorine is not a large constituent of soil, nor does it perform a very important part in the soil's work, yet it is found uniformly in plant ash, and is regarded as being in some way essential.

MANGANESE.—Is formed in some soils but not in all. It is found in the ash of some plants, but is not considered to be an essential constituent for plant growth.

ALKALINE SOILS.

This name is given to those soils common throughout a large part of the United States, and particularly in the *arid belt*, which contain a considerable portion of alkali salts.

These soils are of importance on account of their abundance and their effect upon vegetation. Some carrying so large a proportion of alkali as to be barren. Outside of California very little work has been done upon this kind of soils.

Their occurrence in this State in large areas warrants our giving a description of their origin and characteristics, with the methods of reclaiming as practiced in California.

It was through the researches of Professor E. W. Hilgard of the California Experiment Station, that the true character of these soils has been revealed, and the following description has been adapted from his excellent papers on the subject:

It is well known that all regions having a deficient rainfall and requiring irrigation for successful agriculture, have tracts of land afflicted more or less with "alkali," that is, showing during the dry season a "blooming-out" of soluble salts on the surface of the ground. This phenomenon is the direct and inevitable result of a scanty rainfall in all regions having a naturally productive soil, from which the mineral matters required for the nutrition of plants are being continually set free by the natural processes included under the general term of *weathering*; a decomposition of the minerals contained in the soil, among the products of which are always the soluble salts of the alkalies (potash and soda). The potash salts are, by a peculiar chemical action, mostly retained in the soil and form an important part of the mineral food of plants; while the soda (or sodium) salts, upon which the soil exerts but a very slight retentive action, are in climates having an abundant rainfall washed currently into the country drainage and thence into the ocean, whose briny waters testify of the long-maintained accumulative process.

Where the rainfall is scanty, and especially where the showers falling at any one time are so light as to wet the soil only to the depth of a few feet, this current washing-out cannot occur, and the sodium salts necessarily accumulate in the soil together with those of potash, lime and magnesia which are, in the ordinary course of events, wholly or in part retained by the soil. As a consequence, each time that the soil moisture evaporates between showers, it carries with it to the surface, in solution, whatever of soluble alkali salts may have accumulated within the depth to which it penetrated, to be again washed down by the next shower, to such depth as its amount may justify. This process is in the natural course of events, indefinitely repeated with one and the same quantity of alkali salts, diminished only to the extent to which some heavier shower may wash part of the surface accumulation to the lower ground. Hence the latter will, as a rule show a larger proportion of alkali on this account alone; in addition, being naturally richer in the fine and easily decomposable mineral powder, carried down and deposited by the streams, the low ground will tend to develop proportionally more alkali than the higher land; and thus we often find such lands, and even the river bottoms, heavily incrusted, when the adjacent uplands are practically free from alkali. But it must not be forgotten that this very fact testifies of the great intrinsic richness of the soil in mineral plant food, and of the highly profitable results sure to follow the effectual reclamation of these low-lying alkali tracts.

The alkali salts vary in composition, but usually consist of three principal ingredients, whose relative proportions vary materially in different regions, and cause corresponding differences in the effects on vegetation, whether natural or cultivated. These three ingredients are, in the usual order of their abundance, common salt (*sodium chloride*), Glauber's salt *(sodium sulphate)*, and salsoda *(sodium carbonate)*. The latter is sometimes present in predominant quantity, and then gives rise to what is popularly known as "black alkali," from the fact that the sodium carbonate forms with the humus of the soil a dark colored solution, which on evaporation in mud puddles, leaves black rings on the soil's surface. The distinction between the "black alkali" and the "white," consisting mainly of the bland and relatively innocuous Glauber's and common salt, is important, for the effect of carbonate of soda upon vegetation is many times more injurious than that of the former, not only because of its direct corroding effects upon the root crown when it accumulates near the surface, but also because, as already stated, it dissolves out of the soil that highly important ingredient, humus or vegetable mold, and, moreover, renders clayey soils almost completely untillable. The latter effect is well seen in the low-lying alkali spots, where (even in the sandy lands) the soil, in which the clay accumulates, is so obstinately caked together, as to render it extremely difficult to put in the plow, and comes up in heavy clods, most difficult to break up. The latter difficulty does not exist in the case of the "white" alkali soils; they till kindly, and the only trouble lies in the accumulation of the salts at the surface in consequence of evaporation, to such extent as to injure the surface roots and root crown. Carbonate of soda or "black" alkali is converted into the "white" (*i.e.*, Glauber's salt) by dressings of gypsum or land plaster, and the relief thus afforded is in very many cases all that is needed to insure profitable cultivation.

It is only in exceptionally bad cases that enough of any of these soluble salts to injure the deeper roots exists in the depths of the soil, or within more than one inch of the surface. The surface accumulation is obvious to the eye during the dry season; at the surface the alkali contents are nearly four times as great as at any point below.

Aside from the three most prevalent ingredients of the alkali crusts, there are always present a number of others, some of which are of fundamental importance to plant life, and of which the mere presence in the soluble form proves that the soil contains in a more or less insoluble shape, but still accessible to the use of plants, all that it can retain of these useful ingredients. Such are particularly the salts of potash, and soluble phosphates, while saltpeter in the form of both potassium and sodium nitrates is common, especially in the "black" alkali districts, and represents a surplus of the most expensive of the fertilizers, which the farmer finds it necessary to apply to his soils, in order to maintain their productiveness. While it is true that these nitrates are not retained by the soil, but pass away with the drainage, their presence testifies of the intensity of the nitrifying process in the soil under the conditions of the local climate.

Thus, while the presence of an excess of alkali salts is an evil, requiring to be abated, yet the above facts, as well as the results of actual trial, prove that alkali soils are eminently worthy of attention and corrective treatment because of their great intrinsic resources in plant food.

The most obvious mode of correcting the condition of alkali soils generally is, clearly, to supplement by artificial means the natural deficiency of drainage *through* the soil, resulting from the scanty rainfall, for, if we once leach out the surplus salts that have accumulated for ages, it will take ages to bring about the same condition of things, and we shall practically have put an end to the " alkali " difficulty.

But this leaching out cannot be done by putting water on the surface of the land, unless at the same time its *removal after passing through the soil* is provided for. For it is manifest that if the alkali solution descends no farther than the subsoil and remains there, ready to reascend so soon as evaporation at the surface calls for it, we shall have done no good. In fact, the inutility of this mode of procedure has been so thoroughly tested in practice, both in California and in India, as to have shown that it is the reverse of useful and increases, instead of diminishing, the evil; because the soluble salts thereafter ascend from greater depths than the annual rainfall could have reached, and their sum total is thus materially increased. This is the simple explanation of what is known as the "rise of the alkali," which is observed in all lands subjected to surface irrigation for some length of time; creating increasing inconvenience and alarm as time progresses.

In the majority of cases judicious cultivation (with the use of gypsum when called for) is capable of preventing any serious damage to crops, yet the present inconvenience and loss resulting from the rise and rapid extension of alkali areas are sufficient to call for strong measures toward the abatement of the evil. The first condition of such abatement is a general understanding of the nature and causes of the trouble. In many cases the improvement cannot be brought about without concerted action (and perhaps even the exercise of the right of condemnation and eminent domain) as is required in the case of irrigation works.

Underdrainage *is the general and absolute corrective for alkali.*

To flood the land until underdrains laid reasonable distances apart shall have run for some time, will end the trouble, not only for the time being, but for centuries; provided only that solid beds of the alkali salts do not underlie. How to deal with that state of things need not now be discussed, as it is the rare exception.

In the porous soils of the Fresno, Cal., neighborhood, where until quite lately alkali was unknown, its rise has clearly been brought about by the rise of the water table, resulting from the establishment of high-lying ditches; and its abatement can be brought about by the same means that have been used for lowering the water itself, that threatened to swamp the very plains that 15 years ago showed no moisture at the depth of 40 or more feet, but where, a few years ago, water was within two or three feet of the surface, drowning out both vines and trees. The establishment of drainage ditches has put an end to this danger wherever it has been properly carried out, and with it the alkali trouble can also be terminated, by thorough flooding of the surface until the ditches shall have carried away the leachings into the country drainage.

There is, however, in certain regions, one difficulty in the way of the success of this operation, namely, the existence of a bed or layer of calcareous hardpan, equally impervious to roots or water. Farmers have already learned that where this hardpan underlies the subsoil at a few feet in depth, trees and vines will not flourish unless it is broken through, so as to enable the roots to pass beneath. This "knocking the bottom out" of the holes into which trees are to be planted has already become a well-understood operation in the hardpan neighborhoods, the crowbar, or even a charge of powder being called into requisition. It is noticeable that in such localities the alkali plague comes soonest and is most persistent, being the natural result of the retention of the alkaline water above the hardpan layer, and its reascent, with all its salts, so soon as evaporation sets in. The hardpan areas are generally basin shaped; with the rise of the irrigation water the latter, with the salts it has leached out of the sub-strata of the soil, will come in around the edges or through the cracks of the hardpan mass, and remaining there despite of drains, will bring an increasing amount of alkali to the surface each successive year, until spots of a few square yards grow into many acres and finally become a serious menace to the welfare of the trees and vines.

The obvious remedy in such cases is to make the drainage ditches deep enough to cut *through* the hardpan, and to knock so many holes in the latter as to facilitate drainage to the necessary extent.

It may be objected that this is too costly; and probably there are cases in which this will be so. It then behooves the owner to consider the choice between a change of location, and the adoption of other crops and repression of the alkali by careful cultivation and the use of gypsum.

It is apparent that so far as the efficacy of the use of gypsum is concerned, each region will have to determine for itself whether or not its alkali is of the black or white type; and as this can be generally readily ascertained by a simple inspection of puddles on alkali ground—whether or not tinted by the dissolution of the vegetable mold into an inky liquid, leaving black rings on evaporation—no one need be long in doubt on that point. Wherever the black tint appears, dressings of land plaster, ranging from 200 to 500 pounds per acre, will usually effect the change from "black" to "white," after one or two irrigations followed by cultivation; preventing the killing of seeds in the ground as well as the dwindling of seedlings after sprouting, and greatly improving the tillage of the heavier soils. Thereafter, the chief measure toward the prevention of the rise of the salts to the surface, is whatever tends to prevent evaporation from the land surface; and therefore, particularly, the maintenance of deep and thorough tilth, and the avoidance of the formation of any surface crusts. These means, together, with a proper choice of crops and mode of culture, will serve to maintain good production in most cases until the radical cure by *drainage alongside of irrigation* shall be justified by the increased value of the land.

ADOBE SOILS.

A peculiar type of soil found in the arid regions is known as adobe, a term which is also applied to the sun-dried bricks made from it, especially in the Mexican settlements of the West and Southwest. This soil occurs in large areas in Colorado, New Mexico, Western Texas, Arizona, Southern California, Nevada, Utah, Southern Oregon, Southern Idaho and Wyoming.*

While occuring throughout the entire arid region, the drainless and lakeless basins of Nevada, offer the most excellent facilities for the study and investigation of adobe.

Wiley* says that "under the microscope it is seen to be composed of irregular, unassorted flakes and grains, principally quartz, but fragments of other minerals are also present. An exhaustive study has not been made, but the samples from widely separated localities show very similar structure." Wiley also publishes the following analysis of adobe :*

	Humboldt Nevada.	Santa Fe, N. M.	Salt Lake Utah.
Silica	44.64	66.69	19.24
Oxide of Aluminum	13.19	14.16	3.26
Oxide of Iron	5.12	4.38	1.09
Oxide of Manganese	0.13	0.09	trace
Oxide of Calcium (Lime)	13.91	2.49	38.94
Oxide of Magnesia	2.96	1.28	2.75
Oxide of Potassium	1.71	1.21	trace
Oxide of Sodium	0.59	0.67	trace
Phosphoric Acid	0.94	0.29	0.23
Carbon di-Oxide	8.55	0.77	29.57
Sulphuric Oxide	0.64	0.41	0.53
Chlorine	0.14	0.34	0.11
Water	3.84	4.94	1.67
Organic Matter	3.43	2.00	2.96

OF WHAT VALUE IS CHEMICAL SOIL ANALYSIS.

When chemistry was first applied to agriculture, it was supposed that the greatest benefit that chemistry could confer upon the husbandman would be derived from soil analysis, and indeed this tenet was apparently confirmed, when Sir Humphrey Davy discovered the cause of barrenness, in a certain soil, to be a superabundance of iron sulphate, and was enabled by the use of lime to decompose the sulphate and remove the barrenness. It was supposed that the fertility of any soil, the kind of crop it was fitted to raise, or the materials which must be added to a soil to develope its productiveness, could all be determined simply by a chemical analysis of the soil. These expectations have not been realized. It was found that chemical analysis can not always distinguish between a productive and unproductive soil, for a soil may be unproductive for physical reasons though it may contain all the necessary elements for fertility.

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* Wiley—Principles and Practice, Agricultural Annual, pp. 57-58.

We are indebted to Liebig for the discovery that the ash of all plants contains the same ingredients, though in varying proproportions. Upon this discovery Liebig based his "mineral manure theory," claiming that as the plant took certain ingredients from the soil, these ingredients must be returned to the soil in order to keep up its productiveness. So working along these lines artificial fertilizers ("mineral manures"), were compounded, but when used failed to bring about the desired results. Having no knowledge of the condition in which the plant food is present in soil, the constituents of these fertilizers were in a very insoluble form, and produced no direct beneficial effect. When at length it was found that, in order to be assimilated by the plant, its food must be in a soluble form, the proposition of artificial fertilization was a simple one. Right here then, is where the weakness of soil analysis shows itself. While it reveals the soil's composition and in what proportions the several constituents are present, *it does not show how much of these elements of plant food is in a soluble or suitable form for assimilation by the plant*. When we are able to show this, and not until then, we shall have reached a point where the practical utility of soil analysis cannot be questioned.

Yet if soil analysis has failed to bear out our hopes when we demanded so much from it, it is no reason why we should say it is of no value. Chemical analysis can aid in determining whether or not a soil is capable of fertility, and in estimating the measure of its possible fertility. There are certain ash ingredients which are absolutely essential for plant growth, in the absence of anyone of which growth is impossible ; if the supply is relatively limited, plant growth will be limited correspondingly. If all the ash elements are present in sufficient amount and *in available form*, such soil is capable of fertility. Hence, chemical analysis of a soil is of importance in determining the *possibility* of fertility, and of the relative fertility which may be secured under the proper conditions.

Station No. **1501**. Locality, Winnie Ranch, north of Carson City, Ormsby county. Cultivated soil. Natural herbage, sagebrush. Crop, sugar beets. Collector, L. G. Winnie.

Station No. **1503**. Locality, one-half mile north of Genoa, Douglas county. Cultivated soil. Natural herbage, grass. Crop, oats. Collector, J. W. Haines.

Station No. **1504**. Locality, Stofiel, Elko county. Virgin soil, meadow land. Natural herbage, wild timothy, wire and red top grasses. Collector, Walter Stofiel.

ANALYSIS.	1501	1503	1504
Coarse materials > 0.5mm. diameter	54.16	28.59	22.86
Fine earth	45.84	71.43	77.14
Total	100.00	100.00	100.00

COMPOSITION OF THE FINE EARTH.	1501	1503	1504
Insoluble Silica	79.41	73.74	72.44
Soluble Silica	0.40	0.40	0.46
Potash (K_2O)	0.81	1.12	1.03
Soda (Na_2O)	0.06	1.59	1.73
Lime (CaO)	2.50	2.90	5.00
Magnesia (MgO)	1.18	0.23	0.17
Br. ox. of Manganese (Mn_3O_4)	0.45	0.45	0.40
Peroxide of Iron (Fe_2O_3)	3.97	5.97	4.00
Alumina (Al_2O_3)	3.88	6.68	6.10
Phosphoric Acid (P_2O_5)	0.35	0.35	0.32
Sulphuric Acid (SO_3)	0.38	0.05	0.06
Carbonic Acid	.....	.....	.....
Water and Organic Matter	6.68	6.40	8.27
Total	100.07	99.88	99.98
Nitrogen in soil	.064	.124	.335

Station No. **1505**. Locality, Harrison Ranch, Lovelock, Humboldt county. Cultivated soil. Natural herbage, sagebrush. Crop, barley. Collector, John Harrison.

Station No. **1506**. Locality, Alt Ranch, Glendale, Washoe county. Cultivated soil. Natural herbage, sagebrush and salt grass. Crop, potatoes. Collector, George Alt.

Station No. **1507**. Locality, Ainley Ranch, Blaine, Elko county. Virgin soil. Natural herbage, sagebrush and grass. Collector, John Ainley.

ANALYSIS.	1505	1506	1507
Coarse materials > 0.5mm diameter	24.52	1.56	27.28
Fine Earth	65.48	98.44	72.82
Total	100.00	100.00	100.00

COMPOSITION OF THE FINE EARTH.	1523	1533	1534
Insoluble Silica	62.31	64.55	73.37
Soluble Silica	0.45	0.40	0.35
Potash (K_2O)	1.79	0.68	1.05
Soda (Na_2O)	0.21	0.21	0.41
Lime (CaO)	4.15	0.80	5.15
Magnesia (MgO)	0.23	4.14	0.22
Br. ox. of Manganese (Mn_3O_4)	0.60	0.40	0.35
Peroxide of Iron (Fe_2O_3)	6.18	5.83	3.74
Alumina (Al_2O_3)	9.72	9.82	6.96
Phosphoric acid (P_2O_5)	0.30	0.41	0.26
Sulphuric acid (SO_3)	0.29	0.05	0.58
Carbonic acid	......	......	......
Water and organic matter	14.33	12.81	8.37
Total	99.94	100.10	1.0029
Nitrogen in soil	.122	.036	.014

Station No. **1508**. Locality, Raine Ranch, Palisade, Eureka county. Cultivated soil. Natural herbage, sagebrush and grass. Crop, wheat and barley. Collector, J. P. Raine.

Station No. **1509**. Locality, Lewers' Ranch, Franktown, Washoe county. Natural herbage, alders. Crop, tomatoes. Collector, Ross Lewers.

Station No. **1510**. Locality, Experiment Station, lower farm, Reno, Washoe county. Cultivated soil. Natural herbage, sagebrush and wild grass. Crop, potatoes. Collector, R. H. McDowell.

ANALYSIS.	1508	1509	1510
Coarse materials, $>$ 0.5mm. diameter	53.12	......	67.18
Fine earth	46.88	......	32.82
Total	100.00	......	100.00

COMPOSITION OF THE FINE EARTH.	1508	1509	1510
Insoluble Silica	80.60	70.71	72.14
Soluble Silica	0.30	0.45	0.80
Potash (K_2O)	0.51	0.97	0.73
Soda (Na_2O)	0.94	0.73	0.49
Lime (CaO)	4.35	2.70	3.30
Magnesia (MgO)	1.29	0.21	1.09
Br. ox. of Manganese (Mn_3O_4)	0.35	0.40	0.40
Peroxide of Iron (Fe_2O_3)	4.18	3.76	8.80
Alumina (Al_2O_3)	2.13	3.99	7.24
Phosphoric Acid (P_2O_5)	0.45	0.73	0.27
Sulphuric Acid (SO_3)	0.24	0.23	0.22
Carbonic Acid	......	.....	......
Water and Organic Matter	4.74	15.23	4.69
Total	100.08	100.11	100.17
Nitrogen in soil	.044	.373	.101

Station No. **1511**. Locality, Dangberg ranch, Carson Valley, near Gardnerville, Douglas county. Cultivated soil. Natural herbage, sagebrush. Crop, wheat and potatoes. Collector, Fred Dangberg, Jr.

Station No. **1512**. Locality, Dutertre ranch, Golconda, Humboldt county. Cultivated soil. Natural herbage, sagebrush. Crop, wheat and oats. Collector, Louis Dutertre.

Station No. **1513**. Locality, Waubuska, Lyon county. Virgin soil. Natural herbage, sagebrush. Collector, C. H. Gordon.

ANALYSIS.	1511	1512	1513
Coarse materials $>$ 0.5mm. diameter		47.66	14.42
Fine earth	......	52.34	85.58
Total	.....	100.00	100.00

COMPOSITION OF THE FINE EARTH.	1511	1512	1513
Insoluble Silica	76.03	73.50	86.94
Soluble Silica	0.40	0.30	0.30
Potash (K_2O)	0-42	0.91	0.42
Soda (Na_2O)	0.17	1.29	0.83
Lime (CaO)	2.45	2.20	1.85
Magnesia (MgO)	1.08	0.26	trace.
Br. ox. of Manganese (Mn_3O_4)	0.30	0.50	0.35
Peroxide of Iron (Fe_2O_3)	4.52	4.72	4.02
Alumina (Al_2O_3)	7.44	7.70	1.05
Phosphoric Acid (P_2O_5)	0.19	0.28	0.38
Sulphuric Acid (SO_3)	0.17	0.32	0.12
Carbonic Acid	.....	.....	.....
Water and Organic Matter	6.81	7.89	3.90
Total	99.98	99.87	100.16
Nitrogen in soil	.145	.065	.009

Station No. **1514**. Locality, Lewis, Lander county. Virgin Soil. Natural herbage, grass. Collector, E. T. George.

Station No. **1515**. Locality, central portion of Lander county. Virgin soil. Natural herbage, grass. Collector, E. T. George.

Station No. **1518**. Locality, Ely, White Pine county. Cultivated soil. Natural herbage, sagebrush. Collector, Hon. J. W. Adams.

COMPOSITION OF THE FINE EARTH.	1514	1515	1518
Insoluble Silica	75.27	70.15	73.29
Soluble Silica	0.30	0.40	0.10
Potash (K_2O)	0.92	0.54	0.43
Soda (Na_2O)	1.10	1.34	1.95
Lime (CaO)	2.30	3.90	12.00
Magnesia (MgO)	0.18	1.55	2.34
Br. ox. of Manganese (Mn_3O_4)	0.45	0.25	none.
Peroxide of Iron (Fe_2O_3)	4.40	4.74	2.88
Alumina (Al_2O_3)	7.50	8.66	1.73
Phosphoric Acid (P_2O_5)	0.79	0.38	0.19
Sulphuric Acid (SO_3)	0.15	0.42	0.42
Carbonic Acid	......	......	......
Water and Organic Matter	6.63	6.73	6.66
Total	99.99	100.06	99.93
Nitrogen in soil	.064	.124	.106

Station No. **1519**. Locality, Ely, White Pine county. Cultivated soil. Natural herbage. Collector, Hon. J. W. Adams.

Station No. **1520**. Locality, Alt ranch, Glendale, Washoe county. Cultivated soil. Natural herbage, sagebrush and salt grass. Collector, Geo. Alt.

Station No. **1521**. Locality, Truckee Valley, south of Reno. Cultivated soil. Natural herbage, grass. Collectors, McKinney & Fletcher.

COMPOSITION OF THE FINE EARTH.	1519	1520	1521
Insoluble Silica	77.57	76.56	80.59
Soluble Silica	0.15	0.10	0.30
Potash (K_2O)	0.32	0.42	trace.
Soda (Na_2O)	0.48	1.59	1.80
Lime (CaO)	7.99	2.40	1.55
Magnesia (MgO)	1.67	1.10	0.96
Br. ox. of Manganese (Mn_3O_4)	0.30	0.16	0.10
Peroxide of Iron (Fe_2O_3)	4.80	5.87	4.80
Alumina (Al_2O_3)	1.00	4.93	2.98
Phosphoric Acid (P_2O_5)	0.35	0.32	0.30
Sulphuric Acid (SO_3)	0.15	0.29	1.69
Carbonic Acid	.....	.....	.....
Water and Organic Matter	5.32	6.22	4.94
Total	99.99	99.96	100.01
Nitrogen in soil	.111	.157	.078

Station No. **1523** Location, Ely, White Pine county. Sub soil. Natural herbage on surface soil, sagebrush. Collector, Hon. J. W. Adams.

Station No. **1533**. Locality, Rioville, Lincoln county. Cultivated soil. Collector, D. Bonelli. Reported by Mr. Bonelli as " unknown soil."

Station No. **1534**. Locality, Rioville, Lincoln county. Cultivated soil. ·Used as vineyard. Collector, D. Bonelli.

COMPOSITION OF THE FINE EARTH.	1523	1533	1534
Insoluble Silica	69.53	62.88	78.42
Soluble Silica	0.25	0.20	0.20
Potash (K_2O)	trace.	0.72	0.45
Soda (Na_2O)	1.69	0.90	0.68
Lime (CaO)	14.65	12.50	8.10
Magnesia (MgO)	1.81	5.10	2.02
Br. ox. of Manganese (Mn_3O_4)	0.20	0.20	trace.
Peroxide of Iron (Fe_2O_3)	4.80	3.38	1.37
Alumina (Al_2O_3)	0.25	1.81	1.98
Phosphoric acid (P_2O_5)	0.26	0.26	0.35
Sulphuric acid (SO_3)	0.37	3.22	0.72
Carbonic acid	......	......	......
Water and organic matter	6.05	8.85	4.62
Total	99.96	99.90	99.91
Nitrogen in soil	.051	.106	.042

Station No. **1545**, Locality, North of Reno, Washoe county. Foothills. Virgin soil. Natural herbage, bunch grass (*Oryzopsis Weberi)* Collector, F. H. Hillman.

Station No. **1546**. Locality, experimental grass plots, front of Experiment Station Building, Reno, Washoe county. Cultivated soil. Natural herbage, sagebrush. Crop, alfalfa until converted to experiment plots. Collector, F. H. Hillman.

Station No. **1047**. Locality, one mile west of Carson. Virgin soil. Natural herbage. Crop, sagebrush. Collector, R. M. Brambilla.

COMPOSITION OF THE FINE EARTH.	1545	1546	1547
Insoluble Silica	73.04	79.50	76.37
Soluble Silica	0.20	0.40	0.42
Potash (K_2O)	0.46	0.32	......
Soda (Na_2O)	2.20	1.06	0.58
Lime (CaO)	1.60	1.20	1.85
Magnesia (MgO)	1.06	0.45	0.45
Br. ox. of Manganese (Mn_3O_4)	0.15	0.25	0.40
Peroxide of Iron (Fe_2O_3)	8.01	4.86	6.90
Alumina (Al_2O_3)	5.39	5.29	8.25
Phosphoric Acid (P_2O_5)	0.55	0.26	0.38
Sulphuric Acid (SO_3)	0.03	0.08	0.08
Carbonic Acid	......	......	......
Water and Organic Matter	9.54	6.27	4.54
Total	100.23	99.94	100.22
Nitrogen in soil	.074	.074	.032

Station No. **1548**. Locality, Palisade, Eureka county. Cultivated soil. Natural herbage, sagebrush. Crop, rosebushes. Collector, Mrs. J. P. Raine.

Station No. **1549**. Locality, Palisade, Eureka county. Virgin soil. Natural herbage. Collector, Mrs J. P. Raine.

COMPOSITION OF THE FINE EARTH.	1548	1549
Insoluble Silica	79.50	76.18
Soluble Silica	0.40	0.40
Potash (K_2O)	0.32	0.40
Soda (Na_2O)	1.06	2.28
Lime (CaO)	1.20	1.48
Magnesia (MgO)	0.45	0.34
Br. ox. of Manganese (Mn_3O_4)	0.25	0.85
Peroxide of Iron (Fe_2O_3)	4.86	3.14
Alumina (Al_2O_3)	5.29	5.16
Phosphoric Acid (P_2O_5)	0.26	0.38
Sulphuric Acid (SO_3)	0.08	0.14
Carbonic Acid	......	......
Water and Organic Matter	6.27	6.19
Total	99.94	99.94
Nitrogen in soil	.060	.064

ELEMENTS NECESSARY TO INCREASE AND MAINTAIN FERTILITY.

Of all the constituents of soil, there are only three that are of decisive importance to the plant. By this we mean that of the different mineral elements which enter into the composition of the plant, only three are required to increase and maintain fertility in the soil. These three are potash, phosphoric acid and lime. Consequently in the following discussion of the analyses here presented, these three elements will be dealt with chiefly.

It is not to be thought that the other soil ingredients have no effect on the plants. They are no less necessary, but every soil contains them in ample amount.

Professor Hilgard has the following to say of the occurrence of potash, phosphoric acid and lime in soils:

"The *lime* percentage should not fall below 0.1 per cent. in the lightest sandy soils; in clay loams not below 0.25 per cent., and in heavy clay soils not below 0.5 per cent.; and it may advantageously rise to 1 and even 2 per cent. as a maximum. Beyond the latter figure it seems in no case to act more favorably than a less amount, unless it be mechanically.

"The percentage of *phosphoric acid* is that which, in connection with the lime, seems to govern most commonly the productiveness of our virgin soils. In any of these, less than 0.05 must be regarded as a serious deficiency, unless accompanied by a large amount of lime. In sandy loams, 0.1 per cent., when accompanied by a fair supply of lime, secures fair productiveness for from eight to fifteen years; with a deficiency of lime, twice that percentage would only serve for a similar time.

"The potash percentage of heavy clay upland soil, and clay loams, ranges from 0.8 to 0.5 per cent.; lighter loams from 0.45 to 0.30 per cent.; sandy loams below 0.3 per cent. and sandy soils of great depth may fall below 0.1 per cent. consistently with good productiveness and durability. Virgin soils falling below 0.6 per cent. in potash seem in most cases to be deficient in available potash, its application to such soils being followed by an immediate great increase of production. Sometimes, however, a soil very rich in lime and phosphoric acid, shows good productiveness, despite a very low potash percentage, and conversely, a high potash percentage seems capable of offsetting a low one of lime."

COMMENTS ON THE ABOVE ANALYSES.

The foregoing analyses are of soils typical of the regions from which they were taken. While the work as yet done is by no means exhaustive, the analyses show the State to be possessed of strongly fertile soils. The results of the analyses, in the case of the cultivated soils, are supported by the abundant crops grown thereon. No. 1501 carries a good proportion of potash, phosphoric acid and lime. No. 1503 and No. 1504 contain a large amount of potash, good proportion of phosphoric acid, and No. 1504 quite an amount of lime. In these last two soils the soda is in excess of the potash; this we find to be the general rule so far as work finished indicates, in soils of the arid regions, and it is easily accounted for by the fact that soda and other salts have a tendency to accumulate in the soil in these regions.

No. 1505 is strong in potash, good in phosphoric acid and carries an abundance of lime. This soil is backed by a crop producing record which indicates a soil of great fertility.

No. 1506 is a little lighter in potash than No. 1505, but carries more phosphoric acid and lime. This soil also has a good crop producing record. No. 1507 carries considerable lime, good amount of potash and a fair quantity of phosphoric acid. No. 1508 shows a fair percentage of potash and phosphoric acid, and considerable lime. No. 1509 is strong in potash and phosphoric acid and good in lime. This soil has proven itself to be a fine fruit soil and on it are raised the finest fruits of the Washoe Valley. All of the small fruits and berries, as well as apples, pears and peaches, thrive on it. The soil proper averages about three feet in depth and underlying it is a peat bed from five to six feet in depth.

No. 1510 is a well balanced soil. It is the soil of the lower Station farm, and although not all that could be desired mechanically, has been proven to be fertile and especially adapted to the growth of sugar beets, potatoes, hops, etc.

No. 1511 and No. 1512 are fair in potash, good in lime, but run a little low in phosphoric acid. No. 1513—A virgin soil;

runs fair in potash, a little low in phosphoric acid, which, with the fact that the lime percentage is not very strong, would seem to indicate that the fertility of this soil in its present condition would not be very high.

No. 1514 and No. 1515 are both very fair soils, so far as the analysis indicates. No. 1518 is low in phosphoric acid, fair in potash, and high in lime, and, as is the case with No. 1514 and No. 1515, carries considerable soda. No. 1519 seems to be a very fair soil, with a large amount of lime and a fair amount of potash and phosphoric acid. No. 1520 was reported to the Station as a soil appearing in patches in the field from which No. 1506 was taken, and on which very little vegetation would grow. It is a little high in soda, which is mostly in the carbonate form. To this, undoubtedly, is due the failure to produce crops. No. 1521 contains a trace only of potash, is but fair in phosphoric acid and lime and carries 1.69 per cent. sulphuric acid (SO_3).

No. 1523 is a sub-soil which was sent in without the surface soil. It contains but a trace of potash, 0.26 per cent. of sulphuric acid and over 14 per cent. of lime. No. 1533—a soil marked "*unkind soil*" is rather weak in phosphoric acid, good in potash, but carries considerable lime, both as carbonate and sulphate. From the data received with the soil, we infer that grape vines will not live in it. We regret not having data concerning the depth of the soil, and also a sample of the sub-soil. It is often the the case that a layer of hardpan occurs at a depth of two to three feet below the surface, sufficiently hard to resist the passage of downward roots, as well as the rise of water, and thus cause the death of the vines.

No. 1534 is a soil on which grape vines thrive and the analysis indicates a soil of good fertility. No. 1545 is a virgin soil on which a variety of bunch grass thrives. It has a good proportion of potash and phosporic acid, but not much lime. The soda is rather high, but the proportion would be reduced by cultivation. No. 1546 is a soil on which alfalfa has grown for a number of years and which has not been fertilized; it is only fair in its contents of potash and phosphoric acid as compared with the soils of high fertility here given.

No. 1547 is a virgin soil very peculiar in its physical appearance, which is more that of quartz mill tailings than anything else. It carries no potash, or at least not in sufficient quantity to be estimated, not enough phosphoric and lime to make up for the lack of potash in fertility. No. 1548 is a soil on which rose bushes thrive, while No. 1549 is a soil on which they will not grow. The soda in No. 1549 is largely in the form of the carbonate.

The work of soil analysis is so arduous that we can undertake the work only on samples which we know to be representative. Persons desiring soil analyzed will please communicate with the chemist of the Station before sending samples.

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